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HIPS
KNEES
ANKLES
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National Joint Registry

19th Annual Report 2022

Surgical data to 31 December 2021

ISSN 2054-183X

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Additional data and information can also be found on page 4 of the report.

Introduction

The National Joint Registry (NJR) collects information about hip, knee, ankle, elbow and shoulder joint replacement operations (arthroplasty) from all participating hospitals in England, Wales, Northern Ireland, the Isle of Man and Guernsey. Described as a global exemplar of an implantable medical device registry, the NJR continues to be the largest orthopaedic registry in the world, with an international reputation.

The registry's purpose is to record patient information and provide data on: the performance and longevity of replacement joint implants: the surgical outcomes for the hospitals where these operations are carried out; and on the performance outcomes of the surgeons who conduct the procedures. We produce this Annual Report, summarising our work and sharing the analysis of data for the past year, visually in tables and graphs, for procedures across each of the joints, as well as implant and hospital outcomes.

PROMs questionnaires completed by patients themselves are a valuable tool in giving insight as to how a patient feels and functions, both before and after surgery, therefore being an important measurement of the success of their joint replacement. Our report this year has a section on how PROMs data might best be handled to integrate with NJR routine reporting and thus add an additional dimension in the reporting of the performance of joint replacements.

This year's report also illustrates the continued impact of COVID on the number of procedures undertaken, which is having a resulting negative impact on the quality of life for patients being left in pain and with issues around reduced mobility. You can see the figures regarding current procedure volume compared to pre-COVID years **here**.

Registry data for the reduced volume of surgery that has taken place this past year, have again been analysed by expert statisticians and the results published - device outcome results are also shared with implant manufacturers. The report also includes some short excerpts which showcase the NJR's contribution to orthopaedic research activity, demonstrating the value of the use of this collected data. A key message from the report is that safety and clinical outcomes continue to improve, as identified through the reduction of revision surgery.

The work of the NJR and the contribution of patients

The registry has shown that orthopaedic surgery, as one of the main users of implant devices in the UK, is demonstrating the highest standards of patient safety with regard to their use. Patient representatives are actively involved in our workstreams and committees and with over 3.5 million records, registry data are also made available under strict security conditions to medical and academic researchers, to further progress the pool of work in measuring and understanding which practices provide better outcomes.

Our data collection and analysis work provides the evidence to drive the continuous development and implementation of measures, to ensure implant safety and the enhancement of patient outcomes is always top of the agenda alongside a focus on reduced revision rates year-on-year, as well as improvements in standards in quality of care whilst also addressing overall cost-effectiveness in joint replacement surgery.

We are very grateful to all patients, who having undergone a joint replacement, have provided their data to the registry over the years, which has enabled us to collect and develop such a rich and valuable data source. The NJR is also appreciative of the work of data entry staff in all participating hospitals, who willingly engage in our stringent data quality award programmes to ensure our information is of high quality, accurate and as complete as is possible.

* use MY data

This work uses data provided by patients and collected by hospitals as part of their care and support.

Summary of content for the NJR Annual Report

Summary	Content	Full information can be found
Introduction	Introduction to the NJR and Foreword from the outgoing and incoming Chairs of the NJR Steering Committee	In this report and via reports.njrcentre.org.uk
Executive summary	Summary of this year's report by the NJR Editorial Committee Chair and NJR Medical Director	In this report and via reports.njrcentre.org.uk
Clinical activity 2021	Statistics on joint replacement activity for hip, knee, ankle, elbow and shoulder activity for the period 1 January to 31 December 2021	reports.njrcentre.org.uk through interactive reporting
Outcomes after joint replacement surgery 2003-2021	Detailed statistical analyses on hip and knee replacement surgery using data from 1 April 2003 to 31 December 2021. Analysis of primary ankles representing data collected since 1 January 2010. Analyses on data for elbows and shoulders using data collected since 1 April 2012	In this report
Implant and unit-level activity and outcomes	Indicators for hip and knee joint replacement procedures by trust, Local Health Board and unit. Plus commentary on implant performance and those that have higher than expected rates of revision and were reported to the MHRA	In this report and via reports.njrcentre.org.uk and download area
Developments	Information on the work of the NJR committees and NJR developments to 31 March 2022	reports.njrcentre.org.uk
NJR governance and operational structure	Composition, attendance, declarations of interest for the NJR Steering Committee, sub-committees and terms of reference	reports.njrcentre.org.uk and download area
Research	Published and approved research papers using NJR data	In this report and via reports.njrcentre.org.uk and download area

NJR Reports online

Clinical activity 2021 overview

The interactive portion of our 19th Annual Report can be found online via the registry's dedicated NJR Reports website at: reports.njrcentre.org.uk

Here we present data on clinical activity during the 2021 calendar year. This includes information on the volumes and surgical techniques in relation to procedures submitted to the registry, with the most recent data being for the period 1 January 2021 to 31 December 2021. To be included in these tables and graphs, all procedures must have been entered into the registry by the end of February 2022.

The double page infographic spread at the end of this report offers a visual summary of key facts relating to the analysis of clinical activity during the 2021 calendar year. This can also be downloaded as a waiting room poster via **reports.njrcentre.org.uk/downloads**

The information found online now includes historical data, going back to 2005 in most cases. Using the dedicated website, readers are able to use interactive, filterable graphs to identify the key information and trends associated with the following reports for hip, knee, ankle, elbow and shoulder data (where sufficient data are available):

- Total number of hospitals and treatment centres in England (including the Isle of Man and Guernsey), Wales and Northern Ireland
- Number of participating hospitals and the number and type of procedures performed
- Number of procedures undertaken as a proportion of all procedures submitted annually
- Procedure details by type of provider
- Primary procedure details by type of provider
- Types of primary replacements undertaken
- Patient characteristics for primary replacement procedures, according to procedure type
- Age and gender for primary replacement patients
- Patients' physical status classification (ASA grades) for primary replacement procedures
- Body Mass Index (BMI) for primary replacement patients
- Indications for primary procedure based on age groups
- Surgical technique for primary replacement patients
- Thromboprophylaxis regime for primary replacement patients, prescribed at time of operation
- Reported untoward intra-operative events for primary replacement patients, according to procedure type
- Patient characteristics for revision procedures, according to procedure type
- Indication for surgery for revision procedures
- Trends in use of the most commonly used brands

For hips specifically

- Components removed during hip revision procedures
- Components used during single-stage hip revision procedures
- Trends in femoral head size and hip articulation

For knees specifically

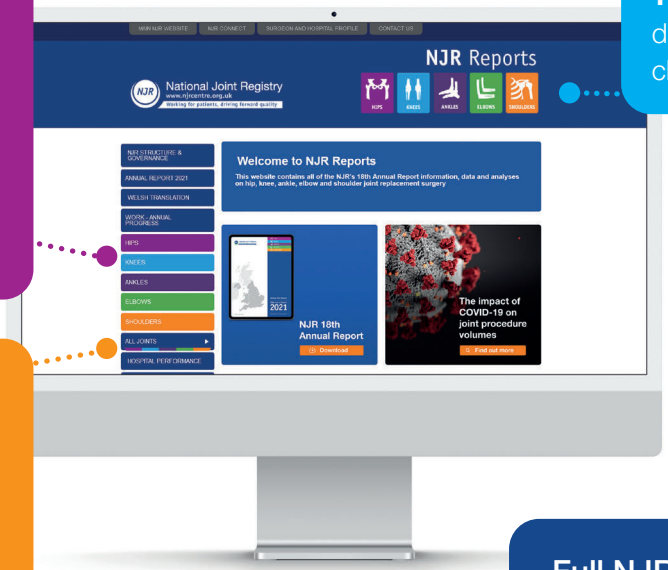
- Implant constraint for primary procedures
- Bearing type for primary procedures

Navigating NJR Reports online

What can you find at NJR Reports online?

Navigate the left hand tabs to view information on the volumes and surgical techniques in relation to procedures submitted to the registry.

Left hand tabs: the information is segregated by report and information type. A wealth of updates are available, from further information on data collection and quality, to the work of our committees and progress of NJR developments.



Top tabs: go straight to the data for each joint type by clicking on the joint icon.

There is also **implant and hospital specific information** available, a **glossary** and a downloadable **infographic** to make all the information as accessible as possible to all our visitors.

Full NJR Reports website at:
reports.njrcentre.org.uk

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1. Foreword

Chair's Foreword

Outgoing interim Chair – Mr Tim Wilton

Over the last year I have undertaken the role of interim Chair of the NJRSC, following the departure of our previous Chair, Laurel Powers-Freeling and pending the appointment of her successor Professor Sir Paul Curran from 1 May 2022. I thank Laurel for her invaluable service to the NJR over the previous ten years and I welcome Sir Paul to the NJR and look forward to supporting him as Medical Director and Vice Chair.

During this time the NJR has delivered a challenging programme of work. Details of all our key workstreams and achievements and updates from the previous year, can be found in the section on **NJR Developments**.

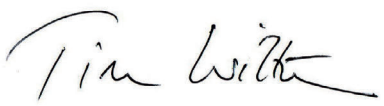
There have been a few changes to NJRSC membership during the period. My sincere thanks to outgoing members, Sandra Lawrence and Jeff Stonadge, industry representatives, for their outstanding contributions and I welcome Joshua Bridgens who succeeded Sandra in April. Also, my thanks to co-opted members Sharon Knight, MHRA representative, for supporting our continued close working relations with the MHRA and Professor John Skinner for his valuable contribution this year (and previously) as BOA President, which continues our important relationship with the orthopaedic profession. I look forward to welcoming their successors.

I am pleased to confirm the re-appointments for a further term of office of Professor Mark Wilkinson, Public Heath/Epidemiology representative, Professor Mike Reed and Professor Amar Rangan, Orthopaedic Surgeon representatives and Professor Karen Barker, OBE, representative Practitioner with a Special Interest in orthopaedics. My sincere thanks to them and all members of the NJRSC and sub-committees, in particular the committee Chairs, for the valuable contribution they make. I would encourage you to read the **committee reports** which provide an insight into the NJR's key work areas.

I also express my gratitude to the orthopaedic surgeons who comprise the NJR Regional Clinical Coordinators (RCCs) committee and who champion our work at local level. We have recruited several new RCCs over the year and I look forward to working with them and further developing our local networks.

Thank you also to the NJR contractors: NEC Software Solutions UK Limited and the University of Bristol, with congratulations to both for their success in being awarded the contracts once again, following a rigorous procurement process undertaken last year. My appreciation goes to Professor Ashley Blom who stepped down after eleven years as the contract lead at Bristol. I very much look forward to working with his successor Professor Michael Whitehouse.

Finally, special thanks to the NJR Management team who support the work of the NJR and its committees which are increasingly diverse and complex. The work this year with re-procurement of our main supplier contracts has been especially exacting and the team has risen to these and other challenges with energy and good humour despite the difficulties of working with all the constraints of the pandemic. My particular thanks go to Elaine Young, Chris Boulton and Yemi Garuba for keeping all our plans on track.



Tim Wilton
NJR Medical Director

Incoming Chair – Professor Sir Paul Curran Appointment from 1 May 2022

It is a great honour to have been appointed as Chair of the world's largest registry of joint replacement surgery. What I particularly like about the NJR is its standing as a pioneering, trusted and collaborative registry, that produces significant benefit for patients. This is an exciting time to be joining the NJR as it informs the ambitious national agenda to develop a medical device information system for patient safety and starts to harness the power of big data analytics.

I first became aware of the important contribution this registry made when, as Chair of the national Review Body on Doctors' and Dentists' Remuneration, we used the Carter Review evidence on how best to reduce variation in patient outcomes. My review of this 19th NJR Annual Report has provided me with the opportunity to reflect on the considerable amount of work undertaken by the registry over the past year, and the contribution it has made to patients, the orthopaedic profession, implant manufacturers and the many stakeholders who support or are served by the NJR. I commend the Editorial Committee Chair, Professor Mike Reed and committee members, who produced this excellent and informative document.

Already in my induction meetings, I have had the pleasure to meet many of the talented professionals involved in the work of the NJR. I am immensely proud to be working with such a committed team of people who have contributed to the status of the NJR as a global exemplar of a medical device registry.

Particularly, I would like to thank my predecessor Laurel Powers-Freeling, who served as the NJR Chair for ten years until April 2021 and during this time led the registry through a period of significant development and achievement. My sincere thanks also go to Mr Tim Wilton, NJR Medical Director and Vice Chair, who undertook the role of interim Chair until my recent appointment. I am grateful to him for his leadership of the registry during this time.

Finally, the 19th NJR Annual Report is a welcome reminder of what a privilege it will be to be Chair during the next stage of the NJR's evolution and I am looking forward to meeting and working with everyone involved in its work.

Professor Sir Paul Curran
Chair, National Joint Registry
Steering Committee

2. Executive Summary

Executive summary

Professor Mike Reed
Chair, Editorial Committee

Mr Tim Wilton
NJR Medical Director

Much as we reported last year, there has been a significant impact of the COVID-19 pandemic on the volume of all joint procedures. Activity in 2020 was roughly half that of normal, and in 2021 was found to be around 70-85%. Interestingly, hip replacement activity was the most preserved of all the joints (85%) and this may indicate these patients being given higher priority.

We were pleased to be able to support the BASK, BESS and BHS annual conferences with a presentation on NJR's work from senior NJR clinicians. Each session was followed by a lively open question session with delegates who were interested in hearing how the NJR is supporting the work of the orthopaedic sector to deliver high quality care to their patients. Considerable interest has been generated by our finding of significant differences in revision rates between variants within the same brand of implants. The NJR regional compliance team was also present at each event, manning our information stand and offering support to surgeons in using our new reporting portal, NJR Connect – Data Services.

Meanwhile the work of the NJR Editorial Committee has continued with development of the strategy and style of the report. All members take responsibility for producing a report that is rigorously edited, taking almost a full year to prepare for, write and review. The Committee brings together experts on data collection and reporting as well as generous input from a patient perspective, clinicians from specialist societies and members of the NJR Management Team. Each year we aim to make progress in reporting on our rich data resource, making data easily accessible to best inform patient-centred care.

This year we present an additional section on Patient Reported Outcome Measures (PROMs) which showcases our current ideas on reporting hip and knee PROMs at the implant brand level in future years. This year we describe the completeness of the data available from the National PROMs programme, explore whether the available data is generalisable to the entire cohort, describe a non-inferiority approach to the analysis and the issues with that approach in the context of routine reporting and interpretation and also propose a model for future reporting. We

are keen to get feedback from all stakeholders, but particularly surgeons, patients and industry. We also share a case study from South West London Elective Orthopaedic Centre showing the benefits of using NJR data in improving patient outcomes.

Although it is not clearly reflected in the data, surgical teams have been reporting increased complexity and comorbidity, as patients have been waiting longer for surgery in comparison to 2019. This may affect outcomes in future years.

We launch the report each September at the British Orthopaedic Association (BOA) Congress and this year the report has been published online only. Increasingly there is considerable additional information available online and we would encourage you to explore the NJR's dedicated annual report website at **reports.njrcentre.org.uk**. The website offers a helpful interactive platform for the descriptive NJR data, with many supporting appendices.

Commentary on findings

Hip replacement

We are now at 18.75 years since NJR inception and thus we have reported at up to 18 years follow-up although in some areas the numbers at risk are low. Surgeons are now performing a median of 59 primary procedures over three years, and 498 per unit. This is a huge drop over the timescale of the COVID-19 pandemic with the last unaffected reporting period being the 2019 annual report.

What are we implanting?

In terms of fixation type and bearing, cemented metal-on-polyethylene (MoP) hip replacement still dominates across the life of the registry, but in 2021 ceramic-on-polyethylene (CoP) hybrid hips were the most often implanted (see Table 3.H2). Dual mobility operations continue to increase with 2021 being the biggest year for their use despite the pandemic (Figure 3.H1 (b)). Although now more common than resurfacings and almost as common as reverse hybrid hips, it is still a minor player in terms of numbers overall (Figure 3.H2 (b)).

Within fixation types, the use of CoP implants continues to grow and now clearly dominates in both uncemented and hybrid hips. Ceramic-on-ceramic (CoC) use is dropping in all uncemented and hybrid fixations (Figures 3.H3 (b) and (c)). In both uncemented and hybrid CoP hips, both 32mm and 36 mm heads have been similarly popular in 2021 (Figure 3.H3 (e)).

What are the results?

At ten years and greater CoP bearings now outperform MoP in revision rates for cemented, uncemented and hybrid hips (although at very extended follow-up it is not always significant) (Table 3.H5). This is good news given their increasing popularity, although this data may be confounded by more frequent use of highly cross-linked polyethylene in these modern bearings which could be partially responsible for the observed pattern.

A key message from the hip section of our report is that the five-year revision rates of metal-on-polyethylene-on-metal (MoPoM) dual mobility bearings appear higher than most cemented and uncemented unipolar combinations (apart from metal-on-metal (MoM)). Ceramic-on-polyethylene-on-metal (CoPoM) may be better but it is difficult to know at this point. Dual mobility patients are of a different demographic to those having a unipolar total hip replacement (THR) and this may be a reason for difference in results (although older patients generally are found to have lower rates of revision in the registry - Table 3.H5). Infection and periprosthetic fracture appear to be common causes of revision (Table 3.H9).

As noted before, younger patients have a higher rate of revision than older ones, and this difference is most marked in women, with younger women having the highest revision rates as a group, and older women the lowest. (Figure 3.H9 (a))

CoP bearings seem to have a particular advantage over MoP in younger age groups (Table 3.H6). We should note that resurfacing in males under 55 has a revision rate of double that of some of the alternatives out at 15 years, even though that is the group for whom resurfacing is still said by some to be appropriately indicated.

Head size and bearing construct revision rates are complex and the details are shown in Figures 3.H10 (a) to (l). Broadly though, head sizes for both cemented MoP and CoP hips seem to be optimal at 28mm and 32 mm with sizes outside of these ranges having higher revision rates. In uncemented hips with a CoP bearing the head sizes of 32mm or 36mm appear optimal (Figure 3.H10 (e)).

Overall, there are excellent results for many different brands of hip replacements, many of these have been used in large numbers and have failure rates substantially lower than 5% at ten years. Tables 3.H7 and 3.H8 give revision rates for different brands of primary hip replacements by fixation and bearing and are worth careful consideration. Costs are a factor in our decision-making and Table 3.11 has clear information on the lifespan of patient age groups by gender. The current NHS England Best Practice Tariff recommendation supporting cemented or hybrid prostheses for most patients over 70 can be supported by these data. Costs are a factor in our decision-making and Table 3.H11 has clear information on the lifespan of patient age groups by gender. The current NHS England Best Practice Tariff recommendation supporting cemented or hybrid prostheses for most patients over 70 can be supported by these data.

In procedures for acute trauma, numbers of patients receiving dual mobility and total hip replacements have not recovered post-pandemic possibly because of other factors like the publication of the HEALTH trial (Bhandari M, et al., 2019). In contrast to elective practice, dual mobility hips don't appear to have an increased revision rate in trauma patients, although specific trials are underway to study this.

Knee replacement

As with hip replacement we now report knee replacement outcomes up to 18 years, based upon over 1.4 million primaries.

What are we implanting?

Across the life of the registry, unconstrained cemented fixed bearing total knee replacement (TKR) still dominates the registry (58%) with posterior stabilised cemented fixed bearing TKR being the next biggest group at 20%, although the use of posterior stabilised implants has been dropping over the last ten years. Both cemented (mainly fixed bearing) and uncemented/hybrid (mainly mobile bearing) unicondylar knee replacements are on the increase as a proportion of knee replacement, moving from a total of 8% to 13% over the last ten years. In terms of actual numbers of procedures, unicondylar knees have increased rapidly since 2013 until the COVID-19 pandemic began. Surgeons performing total knee replacement over the last three years have carried out a median of 86 cases and those performing unicondylar a median of 19; pre-pandemic the figures were 109 and 21 respectively. These three-year averages are likely to drop again in the registry and this will be reported in the next annual report. Only a small proportion of unicondylar knee procedures are being done by a surgeon who performs fewer than 12 per year. NICE standards in 2022 report on the need for a discussion around unicondylar versus total knee replacement for isolated medial osteoarthritis and this will likely drive its use in the future.

What are the results?

Since 2008, revision rates have continued to improve out to ten years. It is very difficult to ascribe a particular reason for the early increased revision rate pre-2008, although it may be attributable to the improved linkage between primary and revision cases over the last 14 years which appears to coincide with the advent of NJR's Clinician Feedback reporting. Reassuringly the current dominant choice of cemented unconstrained is validated in the revision data at ten years and beyond although the monobloc polyethylene tibia TKRs also perform well (in a slightly different group). Overall, some high-volume brands of total knee replacement are showing 2.5% revision rates or less at ten years. The best performing and popular unicondylar knee brands are around double that, although in patients five to six years younger (Table 3.K9 (a)). Patellofemoral replacement revision rates come in around five times higher than a cemented TKR at 10 or 18 years.

Bhandari M et al.; Total Hip Arthroplasty or Hemiarthroplasty for Hip Fracture. Value Health. N Engl J Med 2019; 381:2199-2208.

Knee replacements in males under 55 fail earlier than for other groups with a revision rate of over 12% at 18 years, and figures show that early revision means a higher chance of re-revision. For women having unicondylar knee replacement however, they are more likely to fail than their age equivalent male counterpart. Detail of knee replacement by brand and by patella resurfacing are presented and readers are encouraged to read the detail relevant to their implant choices. NICE has recently concluded that surgeons should offer patella resurfacing (NICE guidance NG157) but revision outcomes appear to be brand/construct specific. Surgeons are encouraged to examine the performance data of the specific constructs that they use.

Revision of a knee replacement is a significant risk factor for further revision, but this is less pronounced if the primary was a patellofemoral joint replacement. Looking at Figure 3.K6 (b), it is worth noting that uncemented unicompartmental knee replacements that are revised appear to behave like revised total knee replacements with respect to re-revision, not "like a primary" as some may propose.

Ankle replacement

For ankle replacement, data collection began in 2010, with this report now being based on almost 8,000 ankle replacements. All ankle replacement implant brands are uncemented designs but previously some surgeons added cement to the construct. In the latest data this trend appears to have stopped.

Apart from the COVID-19 impacted years, ankle replacement has been increasing rapidly since 2015. This increase has been largely delivered by higher volume surgeons doing more than one case a month. In 2021, with COVID-19, the median number of ankle replacements performed was three. Only 3% of consultants performed 20 or more primary ankle replacements and a further 14.8% performed between 10 and 19 primary ankle replacements.

A single implant brand – INFINITY – now captures over 65% of the market.

Overall revision rates run at around 5.5% at five years (Table 3.A3), with revision rates much higher in the under 65s. The market leader is now tracking at less than a 3% risk of revision at five years, so this is promising but still does not reach parity with total hip or knee replacement. With wide variance of failure rates of differing implants, it is important that surgeons use an implant with either a good track record or one that is being introduced responsibly.

Aseptic loosening, then infection, dominate the indications for ankle revision. With revision, the most common outcome was a single stage revision. Amputation and conversion to arthrodesis are reported as revisions but there remains some concern about under-reporting of both of these.

Elbow replacement

During 2021-22 the NJR Data Quality Committee has overseen a large and detailed exercise to identify missing data and source check for mismatched data. The project was conducted in collaboration with the British Orthopaedic Trainees Association (BOTA), British Elbow and Shoulder Society (BESS), Royal College of Surgeons of England (RCS Eng) and the British Orthopaedic Association (BOA). As a result of the audit, there is a significant increase in the numbers of elbows available for analysis on this report – over 7,000. These new data are mainly radial head replacements but also include previously 'missing' total elbow replacements.

Across the life of the registry there are similar numbers for trauma and elective indications. In 2021, trauma (mostly radial head replacements) dominated with volume activity being relatively consistent with previous years. The use of distal humeral hemiarthroplasty in trauma cases continues to grow. The volume of primary total elbow replacements has marginally increased over the last five years (except for 2020 and 2021 due to the impact of COVID-19) with the number of surgeons that are performing one or two procedures falling annually since 2018. Elective activity in 2020 and 2021 dropped to around 50-60% of normal volumes.

In elective practice, around 50% of total elbow replacements in the registry have used a single implant brand (Coonrad Morrey). In radial head replacement for trauma, the Anatomic brand dominates.

The Total Elbow Replacement revision rate is just over 1% per year for elective indications. Beyond two years, revisions of those primaries performed for trauma appear to be less frequent, but we see low numbers at this point so estimates are less certain.

Shoulder replacement

As a result of a review of the shoulder data in 2018 and 2019, new classification and component attributes are used in the annual report. The analysis team has cross-checked the implanted construct with the indicated procedure at the time of the surgery and positively confirmed the implanted construct matches the reported procedure in just over 90% of cases. A total of 56,312 primary shoulder replacements were available for analysis.

There has been a changing scene in shoulder replacement over the nine years of data reported. There was a continued increasing preference for reverse polarity total shoulder replacement year-on-year until 2019 which has since plateaued, but it is not clear if this is a true plateau or a secondary effect of the impact of COVID-19.

In elective practice, resurfacing humeral hemiarthroplasty, stemmed humeral hemiarthroplasty, stemmed total shoulder replacement, and resurfacing total shoulder replacements have all declined since the start of data collection while stemless total shoulder replacements have steadily increased and the volume of stemmed reverse polarity total shoulder replacements has increased substantially.

In trauma cases, the popularity of stemmed humeral hemiarthroplasty has reduced in recent years while the popularity of stemmed reverse polarity total shoulder replacements continues to increase steadily albeit allowing for the impact of COVID-19 in 2020 and 2021.

Broadly, revision rates for trauma and elective shoulder replacement are a little less than 1% per year, with rates for trauma indications appearing to be even better where follow-up is beyond three years. Reassuringly the increasingly popular elective stemmed reverse polarity total shoulder replacement appears to have revision rates around 0.5% per year. However, these implants are more difficult to revise than other shoulder devices and it remains to be seen whether this is truly a definite advantage of the reverse polarity implant. There are groups, for instance males under 55, who fair much worse with elective shoulder replacement with revision rates over 14% at seven years.

A pre-op PROMs questionnaire is collected by the NJR for shoulder replacement and around 25% of elective patients return these within the correct timescale. Around a third of patients complete a further six-month PROMs but engagement is poor beyond that. At six months following surgery, 5.3% of patients reported a score worse than they did pre-operatively. Patients with a high pre-op score – over 40 on the Oxford Should Score (OSS) - had an equal chance of being better or worse at six months.

Concluding acknowledgements

The NJR continues to work collaboratively with our many stakeholders; the most important, of course, are the patients we serve, and whom we would like to thank for allowing us to use their data.

The NJR operational collaboration is a huge team effort – this year managed almost exclusively by work performed remotely online. Elaine Young, NJR Director of Operations has demonstrated the great versatility of her leadership and her team.

Many thanks also to the following without which the NJR could not function:

All members of the NJR Steering Committee

Members of the NJR sub-committees:

- Executive
- Data Quality
- Editorial
- Implant Scrutiny
- Medical Advisory
- Regional Clinical Coordinators
- Research
- Surgical Performance

Members of the Data Access Review Group

Members of the NJR Patient Network

Other organisations:

- Medicines and Healthcare products Regulatory Agency (MHRA)
- Care Quality Commission (CQC)
- NHS England / Improvement
- NHS Digital
- Getting It Right First Time (GIRFT)
- British Orthopaedic Association (BOA)
- British Hip Society (BHS)
- British Association for Surgery of the Knee (BASK)
- British Elbow and Shoulder Society (BESS)
- British Orthopaedic Foot and Ankle Society (BOFAS)
- European Orthopaedic Research Society (EORS)
- Healthcare Quality Improvement Partnership (HQIP)
- Confidentiality Advisory Group (CAG)
- Association of British HealthTech Industries (ABHI)

We are most grateful to our NJR delivery contractors for their very valuable input into the NJR Annual Report, and many other functions. NEC Software Solutions, University of Bristol and University of Oxford teams help us refine and improve each year.

We offer our personal thanks to Vicky McCormack, Report Project Manager, NEC; Deirdra Taylor, Associate Director of Communication and Stakeholder Engagement and Oscar Espinoza, Design and Communication Manager for the NJR, for getting the final report into shape.

Professor Mike Reed

Chair of the NJR Editorial Committee

Mr Tim Wilton

NJR Medical Director

3. Outcomes after joint replacement 2003 to 2021

3.1 Summary of data sources, linkage and methodology

The main outcome analyses in this report relate to primary and revision joint replacements, unless otherwise indicated. We included all patients with at least one primary joint replacement carried out between 1 April 2003 and 31 December 2021 inclusive, whose records had been submitted to the registry before 1 March 2022.

Information governance and patient confidentiality:

Data are collected via a secure web-based data entry application, then stored and processed in the NEC Software Solutions (NEC) data centre. NEC is ISO 27001 and ISO 9001 accredited and compliant with the NHS's Data Security and Protection Toolkit. Data linkage to other datasets is approved by the Health Research Authority under Section 251 of the NHS Act 2006. Please visit **https://www.hra.nhs.uk/about-us/committees-and-services/confidentiality-advisory-group/**.

Data quality:

High quality data are the foundation of any joint replacement registry and the National Joint Registry fully understands and endorses this. It has been mandatory to record hip and knee procedures for the independent sector since 2003 and for the NHS since 2011. Other joints have been mandatory since they were introduced into the dataset.

The comparison of data entry onto the registry with Hospital Episode Statistics (HES) data gives a clear indication of the degree to which data might be missing or of any anomalies in data entry, but does not itself supply or correct the missing data. For this reason a formal audit cycle, capable of reconciling the two sources of data and allowing their correction, was set up using data from each NHS hospital's Patient Administration System (PAS) and each independent hospital's business administration system.

A comprehensive audit of data quality has been conducted across all hospitals which compares procedures uploaded to the registry with those recorded on a hospital's administration system. Records are identified from the local hospital-based OPCS4 codes and then matched to records held within the registry, see Figure 3.D1 (page 35). Records that are found on the local hospital system but not on the registry can be subsequently uploaded bringing compliance as near to 100% as possible. It is expected that neither the registry nor the local hospital's system alone could be regarded as a definitive list of joint replacements, however, the union of both registry and local hospital data can be considered the gold standard from which to calculate voluntary unprompted compliance at upload. This figure is important for healthcare provider institutions as a measure of compliance with data entry processes but does not represent the final data completeness of records in the registry. It is important to note that nearly all unmatched procedures identified by the audit and where the patient has not declined consent are subsequently uploaded into the registry.

Figure 3.D1 Schematic presentation of NJR data compliance audit.

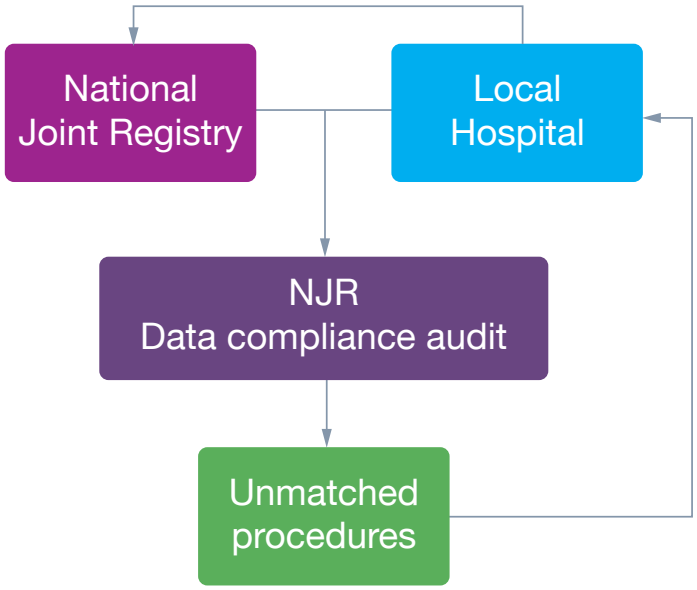


Table 3.D1 Percentage data quality audit compliance.

Procedure	Percentage missing NJR records (%)					
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Hip primary	4.30	5.40	4.19	4.16	2.44	2.86
Hip revision	8.10	11.42	8.74	9.15	4.80	5.81
Knee primary	3.50	4.86	3.83	3.41	1.68	1.94
Knee revision	8.80	12.45	9.25	8.77	4.62	4.81

Note: Percentages for years prior to 2018/19 are pre-audit figures prior to introduction of the automated audit process. Percentages for the 2018/19 audit and beyond are as at 25 April 2022 using the automated process.

The recording of revision procedures in the registry has noticeably improved since the audit has been in place. In the most recently completed audit for years 2019/20, 97.43% of NJR hip and knee records could be matched to HES and local PAS systems.

Since 2019 we have introduced an automated process enabling units to check their data quality on a monthly or quarterly basis. This covers hip, knee, elbow, ankle and shoulder data and we are seeing this being adopted as routine practice in many hospitals. This initiative will greatly reduce the number of mismatches between registry and hospital data. We anticipate that compliance and data accuracy will exceed 99% when the process is fully embedded.

Missing data:

The effect of missing data on the statistical analysis of data is well documented. Data which is systematically missing (Missing Not at Random) has the potential to induce bias i.e. to distort the truth. This is why compliance of reporting data to the registry by a specific consultant or unit is essential to the quality assurance process of consultants and units.

Analysis of data which is missing in either a random (Missing Completely At Random) fashion or random within known strata (Missing At Random), e.g. method of fixation, is known to yield unbiased results. We believe that a coordinated systematic agreement of individuals across the registry to under-report the failure of a specific implant is exceedingly unlikely. Nevertheless, we believe if this did happen the issue would be identified and corrected by the audit process. The low revision rates of either hip or knee replacements also makes it exceedingly difficult to predict which is likely to fail. Therefore, planning to omit selected primary joint replacements which are anticipated to fail within ten years following surgery would be unlikely to succeed. Increased centralisation of some revision joint replacement, by specialist revision surgeons, also means there is little motivation to omit revisions, which would largely have been primary cases of another surgeon or another unit.

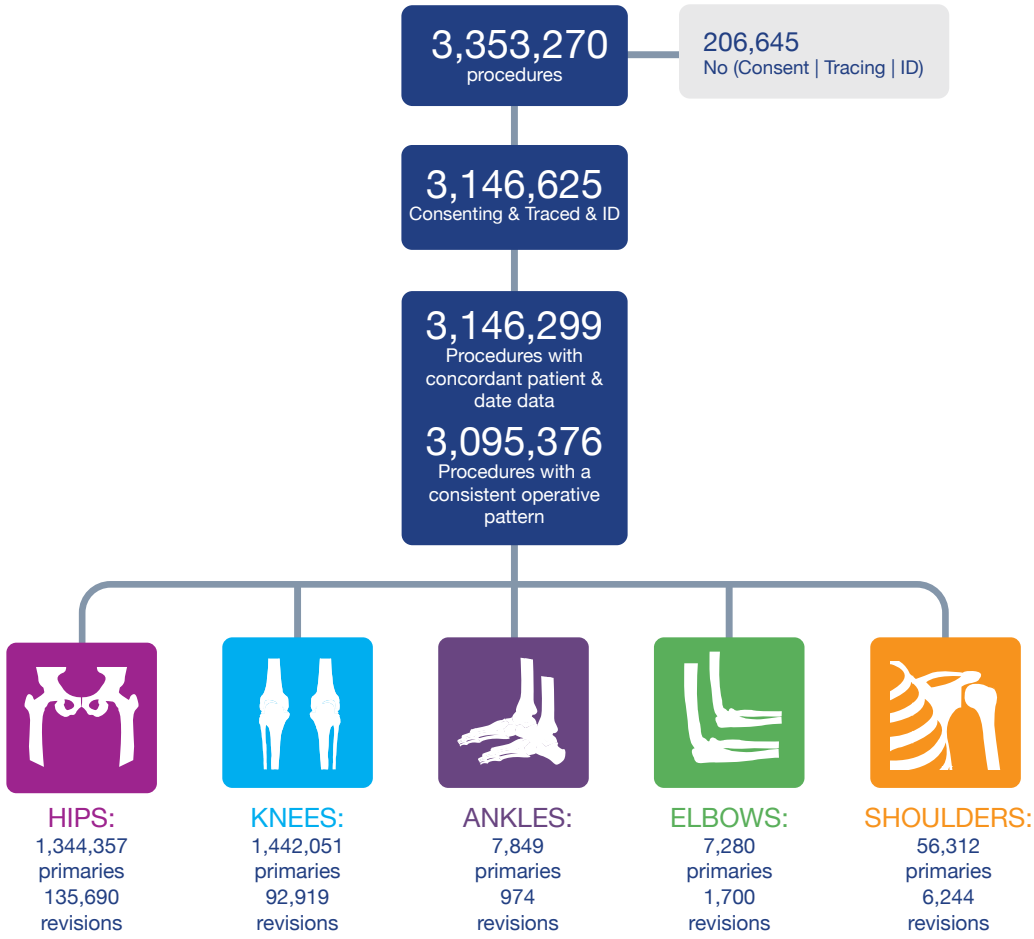
We believe that missing data within the registry can be considered missing completely at random. We propose that this missing data mechanism will ensure that the quality assurance process of implants entered into the registry, consultant and units is statistically valid.

Patient-level data linkage:

Documentation of implant survivorship and mortality requires linkage of person-level identifiers in order to identify primary and revision procedures and mortality events for the same individual.

Starting with a total of 3,353,270 NJR sourced records, 6.2% were excluded because no suitable person-level identifier was found (Figure 3.D2, page 37). Full details of the inclusion and exclusion criteria can be seen at the beginning of each sub-section of each type of joint replacement. Cases from Northern Ireland and Guernsey were also excluded because of unresolved issues around tracing mortality; and cases from the Isle of Man were also excluded due to the inability to audit them against local hospital data. Patients with longer follow-up may be less representative of the whole cohort of patients undergoing primary joint replacement than those patients with shorter follow-up, due to difficulties with data linkage and differential rates of reporting over time.

Figure 3.D2 Initial numbers of procedures for analysis.



Linkage between primaries and any associated revisions (the 'linked files'):

A total of 2,857,849 linked and analysable primary joint replacements have been recorded by the NJR, i.e. hip, knee, ankle, shoulder or elbow. Implant survivorship is first described with respect to the lifetime of the primary joint only. In sections 3.2 and 3.3, we also provide an overview of further revisions following the first hip or knee revision procedure.

As in previous years, the unit of observation for all sets of survivorship analysis has been taken as the individual primary joint replacement. A patient with left and right replacements of a particular type, therefore, will have two entries, and an assumption is made that the survivorship of a replacement on one side is independent of the other. In practice, this would be difficult to validate, particularly given that some patients will have had primary replacements of other joints that were not recorded in the registry. Established risk factors, such as age, are recorded at the time of

primary operation and will therefore be different for the two procedures unless the two operations are performed on the same date.

A revision is defined as any operation where one or more components are added to, removed from or modified in a joint replacement, or if a Debridement And Implant Retention (DAIR) with or without modular exchange is performed. Capturing DAIR with or without modular exchange commenced with the introduction of MDSv7 (June 2018). Prior to this, DAIR with modular exchange was included as a single-stage revision, but DAIR without modular exchange was not captured. Within the annual report, each of these procedure types is included in the analyses as a revision episode. This is distinct from the analyses in the surgeon, unit, and implant performance workstreams where DAIR without modular exchange is not currently included as a revision outcome.

Analytical methods and terminology

The NJR Annual Report uses a variety of statistical methods to reflect the diversity and range of performance within joint replacement. Analyses are tailored to ensure results are reported in units that can be easily interpreted. Here we define important concepts which underpin the analyses in the following sections.

All cause / all construct revision

All cause revision is used as the primary outcome in the majority of analyses due to the difficulties in defining cause-specific failure i.e. several indications may have been given for a particular revision. In addition, we consider the construct as a single entity; for example, in hips we do not differentiate between stem and acetabular failure as it is sometimes difficult to identify which prosthetic element failed first or is causally responsible for the failure. It is incorrect to assume that the failure of implants that make up a construct are independent of each other. In knees, we similarly do not differentiate between failure of components within the tibia, femur or patella. Secondary patella resurfacing after a total knee replacement is considered a revision. In shoulders, elbows and ankles we take the same approach and do not differentiate between the failure of different components within the joint. Conversions of one type of shoulder replacement to another are considered a revision.

Debridement And Implant Retention

Debridement And Implant Retention (DAIR) without modular exchange has been included in the registry data as of MDSv7. DAIRs with modular exchange should have been collected (as a type of single-stage revision) from inception and their reporting in hips, knees, shoulders and elbows, along with all other procedures captured by the NJR, has been mandatory in the NHS since 1 April 2011. Before MDSv7, DAIRs with modular exchange were considered to be a revision in hip, knee, shoulder and elbow but not ankle replacements. In MDSv7, all joint types are treated the same and a DAIR with modular exchange is considered to be a revision in all recorded joint replacements for the purposes of the annual report.

Terminology note: Hip replacements

There are four distinctive categories reflected in the analysis of data collected in the registry and these are: 1) the type of hip replacement i.e. total hip replacements (THR) and hip resurfacings (the NJR does not currently collect data on hip hemiarthroplasty); 2) the fixation of the replacement i.e. cemented, uncemented, hybrid and reverse hybrid; 3) the bearing surfaces of the hip replacement; and 4) the size of femoral head/internal diameter of the acetabular bearing.

Cemented constructs are fixed using bone cement in both the femoral stem and acetabulum. Uncemented constructs rely on press fit and osseous integration within the femur and acetabulum that may be supplemented (e.g. by screw fixation).

Hybrid constructs contain a cemented femoral stem and an uncemented acetabulum. Reverse hybrid constructs contain an uncemented femoral stem and a cemented acetabulum. By convention, the bearing material of the femoral head is listed before the acetabulum. Currently, the eight main categories of bearing surfaces for hip replacements are ceramic-on-ceramic (CoC), ceramic-on-metal (CoM), ceramic-on-polyethylene (CoP), metal-on-metal (MoM), metal-on-polyethylene (MoP), metal-on-polyethylene-on-metal (MoPoM), ceramic-on-polyethylene-on-metal (CoPoM), and resurfacing procedures.

The metal-on-metal group in this section refers to patients with a stemmed prosthesis (THR) and metal bearing surfaces (a monobloc metal acetabular cup or a metal acetabular cup with a metal liner). Although they have metal-on-metal bearing surfaces, resurfacing procedures, which have a surface replacement femoral prosthesis combined with a metal acetabular cup, are treated as a separate category. Ceramic-on-ceramic and metal-on-polyethylene resurfacings are now being implanted and in future reports these will be reported as a new category, although the numbers are likely to remain too small for meaningful analysis for a number of years. Three bearing materials being listed indicates the use of dual-mobility bearing devices. The size of the femoral head or inner diameter of a component is expressed in millimetres.

Terminology note: Knee replacements

Knee replacements within the registry are principally defined by the number and type of compartments replaced, the fixation of the components (cemented, uncemented or hybrid), level of constraint, the mobility of the bearing, whether the implants are of a modular design, and the presence or absence of a patella in the primary knee replacement.

The knee is made up of three compartments: medial, lateral and patellofemoral. When a total knee replacement (TKR) is implanted, the medial and lateral compartments are always replaced, and the patella may be resurfaced. If a single compartment is replaced then the term unicompartmental is applied to the procedure (UKR). The medial, lateral or patellofemoral compartments can all be replaced independently, if clinically appropriate. Medial and lateral unicompartmental knee replacements are also referred to as medial or lateral unicondylar knee replacements. We also use the term multicompartmental knee replacement to indicate the combination of more than one unicompartmental knee replacement.

Knee replacements are also characterised by their level of constraint (stabilisation). For example, there is variation in the constraint of the tibial insert's articulation with the femoral component. Some implants are designed to preserve the posterior cruciate ligament (cruciate retaining; (CR)) referred to in this report as unconstrained. At present this group includes other variants such as medial pivot and cruciate-stabilised designs. Other implants use a mechanism (usually a cam and post design) to substitute for the posterior cruciate ligament, that is removed at the time of surgery (posterior stabilised; PS). In more complex circumstances additional constraint may be necessary to allow the implant to deal with additional ligament deficiency or bone loss (where constrained condylar (CCK) or hinged knee implants may be used) in a primary or revision procedure.

In modular tibial components, the tibial insert may be mobile or remain in a fixed position on the tibial tray. This also applies to medial and lateral unicompartmental knees. Many brands of total knee implant exist in fixed and mobile forms with options for either CR or PS constraint. Tibial elements may or may not be of modular design. Modularity allows some degree of patient-specific customisation. For example, modular tibial components are typically composed of a metal tibial tray and a polyethylene insert which may vary in thickness. Non-modular tibial components consist of an all-polyethylene tibial component (monobloc polyethylene tibia) available in different thicknesses.

We now distinguish between medial and lateral unicondylar knee replacements during the data collection process; however this was not so in earlier versions of the Minimum Data Set form (MDS) i.e. those prior to MDSv7.

In addition, we now report multicompartmental knee replacements which may include unicondylar and patellofemoral or two unicondylar replacements.

With regard to the use of the word 'constraint' here, for brevity, total knee replacements are termed unconstrained (instead of posterior cruciate-retaining) or posterior-stabilised (instead of posterior cruciate-sacrificed).

We assume the absence of a patella in the upload of knee components is indicative that the patella has not been resurfaced.

Terminology note: Ankle replacements

Ankle replacements recorded within the registry are principally uncemented devices. However, in terms of fixation we now report the presence or absence of cement used within the ankle construct. The presence of cement is defined by the inclusion of cement product details within the prosthesis upload.

Terminology note: Shoulder replacements

Shoulder replacements within the registry are principally defined by the type and sub-type of replacement. The four main types of replacement are 1) proximal humeral hemiarthroplasty, 2) conventional total shoulder replacement, 3) reverse polarity total shoulder replacement and 4) interpositional arthroplasty. There are three main sub-types based on variations on the humeral side of the joint. These include 1) resurfacing i.e. putting a new metal surface over the existing humeral head, 2) stemless i.e. removing the humeral head and putting on a new head with an anchoring device which does not project beyond the metaphysis of the proximal humerus, and 3) stemmed i.e. replacing the humeral head and utilising an anchoring device which projects into the diaphysis of the humerus.

Descriptive statistics

In simple cases we tend to report simple descriptive statistics including: numbers (n), frequencies (N=), percentages (%), minimums (min), maximums (max), interquartile ranges (IQR) (25th centile, 75th centile), means (SD) and medians (50th centile) of the data.

Survival analysis methods

In more complex analyses that focus on either implant failure (denoted revision), recurrent implant failure (re-revision) or mortality we use 'survival analysis methods' which are also known as 'time to event' methods.

Survival analysis methods are necessary in joint replacement data due to a process known as 'censoring'. There are two forms of censoring which are important to consider in joint replacement registry data: administrative censoring and censoring due to events, such as death.

Administrative censoring creates differential amounts of follow-up time, i.e. patients from 2003 will have been followed up for more than 18 years, whilst patient data collected last year will have one year of follow-up or less. Survival analyses methods enable us to include all patients in one analysis without being concerned if patients have one day, one year or one decade of observed follow-up time; these methods automatically adjust analyses for the amount of follow-up time.

In the case of analyses which estimate implant failure, death events are also censored, specifically they are considered non-informative censoring events. This assumes that death is unrelated to a failing implant, and can be safely ignored whilst estimating implant failure (revision). See Sayers et al. 2018 Acta Orthopaedica, 89:3, 256-258, for an extensive discussion on this problem.

The survival tables in this report show 'Kaplan-Meier' estimates of the cumulative chance (probability) of failure (revision) or death, at different times from the primary operation. In the joint replacement literature they are often referred to as KM or simply survival estimates. We additionally show 95% Confidence Intervals for each estimate (95% CI). Confidence intervals illustrate the uncertainty around the estimate, with wide confidence intervals indicating greater uncertainty than narrow ones. Strictly they are interpreted in the context of repeated sampling i.e. if the data were collected in repeated samples we would expect 95% CIs generated to contain the true estimate in 95% of samples. However, confidence intervals are strongly influenced by the numbers of prosthesis constructs at risk and can become unreliable when the numbers at risk become low. In tables, including risk tables within figures, we highlight in *blue italics* all estimates where there are fewer than 250 prosthesis constructs at risk, or remaining at risk, at that particular time point.

Kaplan-Meier estimates can also be displayed graphically using a connected line plot. Figures are joined using a 'stair-step' function. Each 'stair' is flat, reflecting the constant nature of the estimate between the events of interest. When a new event occurs the survival estimate changes, creating a 'step'. Changes in the numbers at risk because of censoring do not themselves cause a step change but if the numbers at risk become low, when an event does occur, the stair-step might appear quite dramatic. Whenever possible, the numbers at risk at each time point have been included in the figures, allowing the reader to more appropriately interpret the data given the number of constructs at risk. We highlight in *blue italics* all estimates where there are fewer than 250 prosthesis constructs at risk or remaining at risk at that particular time point. The Kaplan-Meier estimates shown are technically 1 minus the Kaplan-Meier estimate multiplied by 100, therefore they estimate the cumulative percentage probability of construct failure.

In the case of revisions, no attempt has been made to adjust for the risk of death, as analyses attempt to estimate the underlying implant failure rate in the absence of death, see Sayers et al. 2018 Acta Orthopaedica, 89:3, 256-258 for an extensive discussion on competing risks. Briefly, the Kaplan-Meier estimator estimates the probability of implant failure (revision) assuming the patient is still alive.

Prosthesis Time Incidence Rates

Prosthesis Time Incidence Rates (PTIR) are used to describe the incidence (the rate of new events) of specific modes of failure in joint replacement. The PTIR expresses the number of revisions divided by the total of the individual prosthesis-years at risk. Figures here show the numbers of revisions per 1,000 years at risk. PTIR in other areas of research are often known as 'person-time' incident rates, however, in joint replacement registries the base unit of analysis is the 'prosthesis construct'.

Note: This method is only appropriate if the hazard rate (the rate at which revisions occur in the unrevised cases) remains constant across the follow-up period. The latter is further explored by sub-dividing the time interval from the primary operation into smaller intervals and calculating PTIRs for each smaller interval.

3.2 Outcomes after hip replacement

3.2.1 Overview of primary hip replacement surgery

In this section we address revision and mortality outcomes for all primary hip operations performed between 1 April 2003 and 31 December 2021. Patients operated on at the commencement of the registry therefore had a potential 18.75 years of follow-up. This year, follow-up is reported at a maximum of 18 years in the tables and figures, although beyond 15 years the numbers at risk are particularly low in some categories.

Figure 3.H1 (a) (page 44) describes the data cleaning applied to produce the total of 1,344,357 primary hip procedures included in the analyses presented in this section.

Over the lifetime of the registry, the 1,344,357 primary hip replacement procedures contributing to our revision analyses were carried out by a total of 3,923 unique consultant surgeons working across 478 units. Over the last three years (1 January 2019 to 31 December 2021), 241,467 primary hip procedures (representing 18.0% of the current registry volume) were performed by 2,137 consultant surgeons working across 419 units.

Looking at caseload over this three year period, the median number of primary procedures per consultant surgeon was 59 (interquartile range (IQR) 4 to 173) and the median number of procedures per unit was 498 (IQR 251 to 803). A proportion of surgeons will have commenced practice as a consultant during this period, some may have retired, and some surgeons may have periods of surgical inactivity within the time of coverage of the registry, therefore their apparent caseload would be lower.

The majority of primary hip procedures were carried out on females (females 59.8%: males 40.2%). The median age at primary operation was 69 (IQR 61 to 76) years. Osteoarthritis was given as a documented indication for surgery in 1,226,690 cases (91.2% of the cohort) and was the sole indication given in 1,183,460 (88.0%) primary hip replacements.

Figure 3.H1 (a) Hip cohort flow diagram.

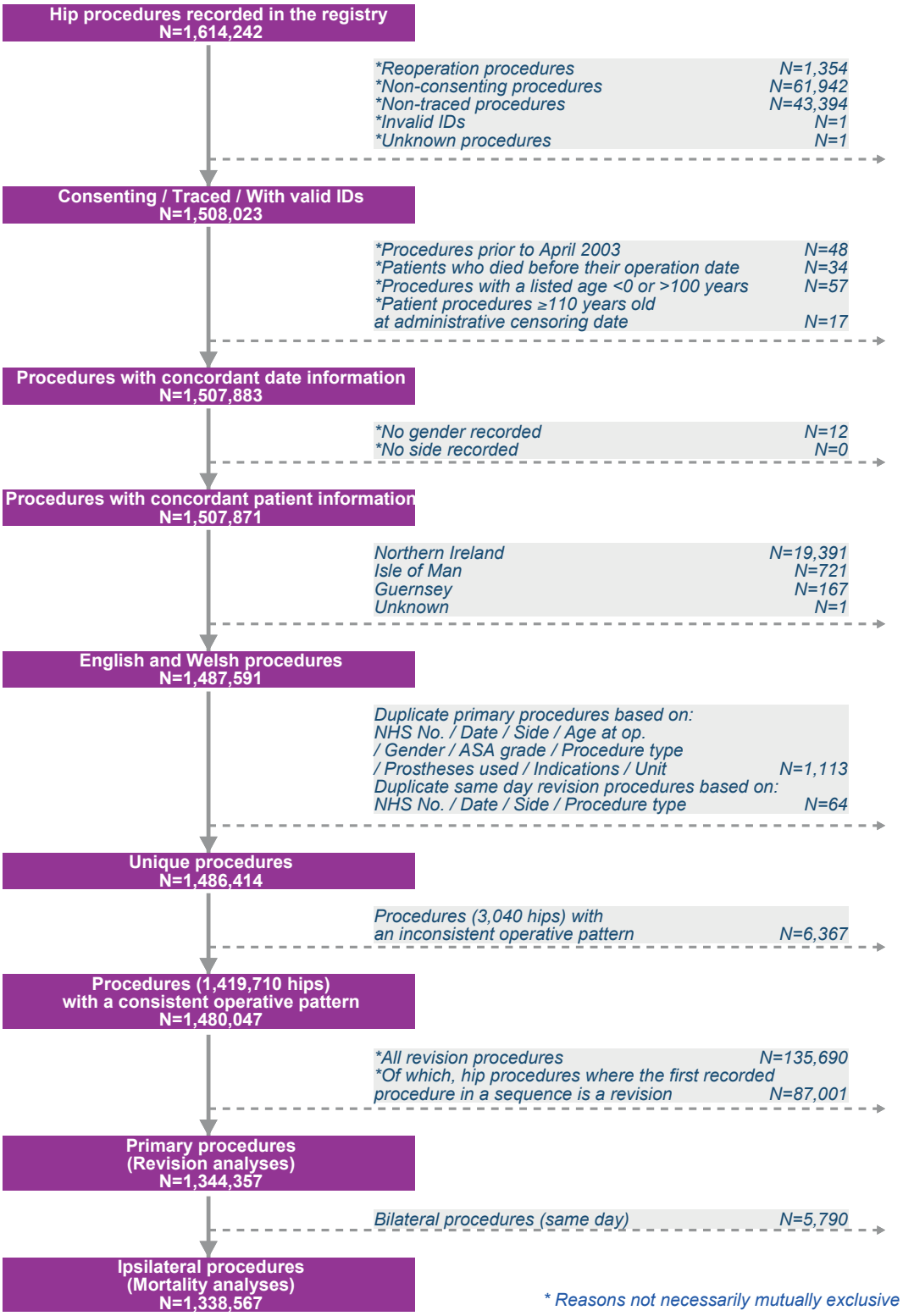


Table 3.H1 Number and percentage of primary hip replacements by fixation and bearing.

Fixation and bearing surface	Number of primary hip operations	Percentage of each bearing type used within each method of fixation	Percentage of all primary hip operations
All cases	1,344,357		100.0
All cemented	412,582		30.7
MoP	354,609	85.9	26.4
MoM	424	0.1	<0.1
CoP	54,659	13.2	4.1
MoPoM	2,574	0.6	0.2
CoPoM	298	0.1	<0.1
Others	18	<0.1	<0.1
All uncemented	498,529		37.1
MoP	192,482	38.6	14.3
MoM	29,235	5.9	2.2
CoP	135,302	27.1	10.1
CoC	137,599	27.6	10.2
CoM	2,151	0.4	0.2
MoPoM	983	0.2	0.1
CoPoM	659	0.1	<0.1
Others	118	<0.1	<0.1
All hybrid	318,261		23.7
MoP	173,224	54.4	12.9
MoM	2,605	0.8	0.2
CoP	109,061	34.3	8.1
CoC	27,573	8.7	2.1
MoPoM	4,285	1.3	0.3
CoPoM	1,364	0.4	0.1
Others	149	<0.1	<0.1
All reverse hybrid	34,797		2.6
MoP	23,602	67.8	1.8
CoP	10,958	31.5	0.8
Others	237	0.7	<0.1
All resurfacing	41,428		3.1
MoM	41,121	99.3	3.1
Others	307	0.7	<0.1
Unconfirmed	38,760		2.9

Table 3.H1 shows the breakdown of cases by the method of fixation and within each fixation sub-group, by bearing surfaces. Bearing surface combinations are reported as a separate group where there were more than 250 cases. The most commonly used operation type overall remains as cemented metal-on-polyethylene (85.9% of all cemented primaries, 26.4% of all primaries). Dual mobility bearings are described either as dual mobility, to contrast to standard unipolar bearings, or where numbers allow, are categorised by the material of each part of the bearing surface (e.g. metal-on-polyethylene-on-metal (MoPoM) and ceramic-on-polyethylene-on-metal (CoPoM)). The numbers of other combinations of dual mobility (such as ceramic-on-polyethylene-on-ceramic (CoPoC)) were too small to include as separate groups this year.

Figure 3.H1 (b) Frequency of primary hip replacements within elective cases stratified by procedure type, bars stacked by volume per consultant per year.

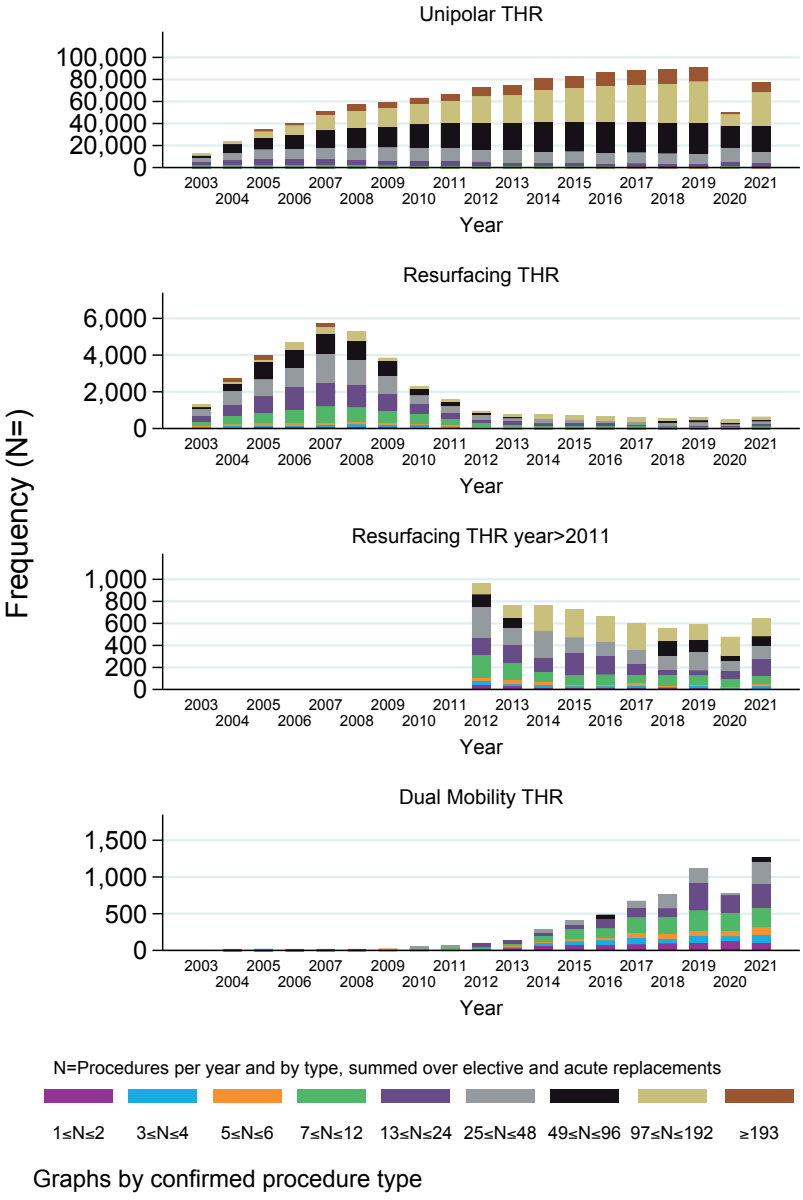
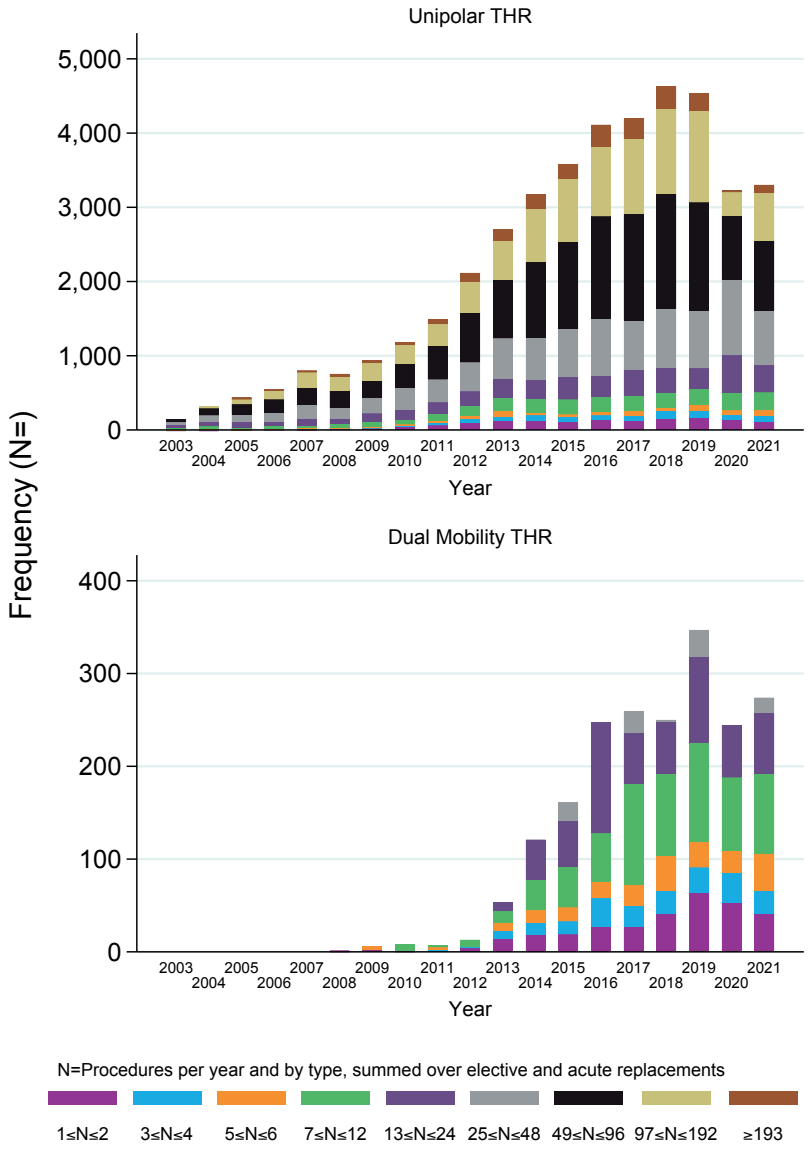


Figure 3.H1 (c) Frequency of primary hip replacements within acute trauma cases stratified by procedure type, bars stacked by volume per consultant per year.



Graphs by confirmed procedure type

Figure 3.H1 (b) and Figure 3.H1 (c) (pages 46 and 47) show the yearly number of primary total hip replacements performed for elective and acute trauma indications respectively. Elective procedures have been stratified by unipolar, resurfacing and dual mobility total hip replacements. Acute trauma procedures have been stratified by unipolar and dual mobility total hip replacements. Please note the difference in scale of the y-axis between each sub-plot.

Each bar is further stratified by the volume of procedures that the consultant conducted in that year across both elective and acute trauma settings i.e. if a surgeon performed 25 elective unipolar THR procedures and 25 acute trauma unipolar elective procedures their annual total volume would be 50 procedures. Those 50 procedures would contribute to the black sub-division in both elective and acute trauma figures.

Figure 3.H1 (b) shows the annual rates of elective unipolar THR increasing, (with the exception of 2020 due to the COVID-19 pandemic with rates partially recovered in 2021), with the majority of additional procedures contributed by higher volume surgeons i.e. those performing more than 49 hip procedures a year. A similar result is also observed in the acute trauma setting with a rapid expansion of unipolar THRs being recorded in the registry from 2011 until 2018, with a plateau in 2019 and then lower rates following the impact of COVID-19 in 2020 and 2021.

Figure 3.H1 (b) also shows that after declining substantially in popularity, resurfacing has remained relatively stable over the past five years. In 2021 over half of the resurfacing procedures were performed by consultants who used it in more than 25 cases per year.

Figure 3.H1 (b) and Figure 3.H1 (c) also illustrate the emerging use of dual mobility THR in the elective and acute trauma settings. Prior to 2013, dual mobility THR was relatively rare, but since 2013 its use has increased in both settings, other than 2020 and 2021 where COVID-19 had an impact on case numbers, and it is now more common than hip resurfacing. Over half of dual mobility operations are performed by consultants who conduct seven or more dual mobility hip replacements per year.

Table 3.H2 Percentage of primary hip replacements by fixation, bearing and calendar year.

Fixation and bearing surface	2004 n= 44,260	2005 n= 41,698	2006 n= 48,561	2007 n= 61,729	2008 n= 67,715	2009 n= 68,663	2010 n= 71,181	2011 n= 74,136	2012 n= 78,351	2013 n= 80,485	2014 n= 87,732	2015 n= 89,908	2016 n= 94,405	2017 n= 96,503	2018 n= 97,563	2019 n= 99,873	2020 n= 56,596	2021 n= 84,998
All cemented	53.5	46.0	40.3	37.3	32.0	30.0	29.5	30.2	31.7	32.1	31.1	30.0	28.5	27.4	26.9	25.7	22.3	21.8
Cemented by bearing surface:																		
MoP	50.4	42.9	37.3	34.7	29.3	27.3	26.4	26.7	27.8	27.7	26.3	25.0	23.4	22.0	21.7	20.3	17.2	15.9
MoM	0.2	0.1	0.2	0.2	0.1	<0.1	<0.1	<0.1	0	<0.1	<0.1	<0.1	<0.1	0	<0.1	<0.1	0	<0.1
CoP	3.0	2.9	2.8	2.4	2.6	2.7	3.1	3.4	3.9	4.3	4.5	4.6	4.7	4.9	4.9	5.1	4.8	5.5
MoPoM	0	0	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.2
CoPoM	0	0	0	0	0	<0.1	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1
Others	0	0	0	0	0	0	0	<0.1	<0.1	<0.1	0	0	0	<0.1	0	<0.1	0	<0.1
All uncemented	18.3	24.1	28.3	31.5	37.3	40.8	43.2	42.8	44.1	41.9	40.3	39.0	38.2	37.5	36.6	35.1	34.8	35.4
Uncemented by bearing surface:																		
MoP	7.5	9.4	9.6	10.1	12.3	14.4	16.0	16.5	17.5	17.2	16.7	16.2	15.9	15.6	15.3	13.6	12.4	12.1
MoM	1.9	5.4	8.3	10.4	11.1	7.9	3.2	0.4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
CoP	5.0	5.0	4.5	4.0	3.8	4.5	5.4	5.9	7.2	8.2	9.5	11.4	12.5	14.1	14.9	15.9	17.1	19.0
CoC	3.9	4.3	5.8	7.0	9.7	13.1	17.4	19.5	19.1	16.3	14.0	11.4	9.7	7.6	6.3	5.3	4.8	3.8
CoM	<0.1	<0.1	<0.1	0.1	0.4	0.9	1.0	0.5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MoPoM	<0.1	<0.1	0	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
CoPoM	0	0	0	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.2
Others	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
All hybrid	12.5	13.9	15.1	14.8	14.7	15.4	15.8	16.7	17.4	19.8	22.7	25.2	27.7	29.8	31.4	34.7	37.8	38.1
Hybrid by bearing surface:																		
MoP	8.7	9.4	9.9	9.9	9.9	10.4	10.7	11.3	11.4	11.9	13.1	13.9	14.8	15.4	15.1	16.5	16.1	15.3
MoM	0.7	0.6	0.7	0.8	0.7	0.4	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1
CoP	1.5	1.2	1.3	1.0	1.3	1.8	1.9	2.2	3.1	5.1	7.0	8.9	10.7	12.3	14.4	16.1	19.4	20.9
CoC	1.7	2.8	3.2	3.0	2.7	2.9	3.0	3.1	2.9	2.7	2.4	2.1	1.6	1.4	1.1	0.9	0.7	0.5
MoPoM	0	<0.1	0	0	0	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.1	1.0
CoPoM	0	0	0	0	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.3	0.5	0.5
Others	<0.1	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note: Data from 2003 have been included in 2004 since 2003 was not a complete year. Percentages calculated as percentage of total yearly operations.
Note: A zero represents no procedures by this bearing type.

Table 3.H2 (continued)

Fixation and bearing surface	2004 n= 44,260	2005 n= 41,698	2006 n= 48,561	2007 n= 61,729	2008 n= 67,715	2009 n= 68,663	2010 n= 71,181	2011 n= 74,136	2012 n= 78,351	2013 n= 80,485	2014 n= 87,732	2015 n= 89,908	2016 n= 94,405	2017 n= 96,503	2018 n= 97,563	2019 n= 99,873	2020 n= 56,596	2021 n= 84,998
All reverse hybrid	0.8	0.9	1.0	1.6	2.4	2.6	2.7	3.1	3.1	3.0	3.1	3.2	3.2	3.2	2.9	2.4	2.2	2.4
Reverse hybrid by bearing surface:																		
MoP	0.5	0.7	0.8	1.0	1.7	1.8	1.9	2.1	2.0	2.0	2.0	2.1	2.2	2.3	2.1	1.6	1.5	1.5
CoP	0.2	0.2	0.2	0.6	0.7	0.8	0.9	0.9	1.1	1.0	1.1	1.0	1.0	0.9	0.8	0.7	0.7	0.9
Others	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
All resurfacing	10.1	10.3	10.4	9.8	8.3	6.2	3.7	2.4	1.4	1.1	1.0	0.9	0.7	0.7	0.6	0.6	1.0	0.8
Resurfacing by bearing surface:																		
MoM	10.1	10.3	10.4	9.8	8.3	6.2	3.7	2.4	1.4	1.1	1.0	0.9	0.7	0.6	0.5	0.6	0.8	0.7
Others	0	<0.1	<0.1	<0.1	0	0	0	0	0	0	<0.1	<0.1	<0.1	0.1	0.1	<0.1	0.1	0.1
Unconfirmed	4.9	4.7	4.9	5.0	5.4	5.0	5.1	4.7	2.3	2.1	1.9	1.6	1.6	1.5	1.6	1.5	1.9	1.5
All	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Note: Data from 2003 have been included in 2004 since 2003 was not a complete year. Percentages calculated as percentage of total yearly operations.
Note: A zero represents no procedures by this bearing type.

Table 3.H2 (page 49) shows the annual rates by fixation and bearing groups for each year for primary hip replacements. The proportion of all hips that are cemented has nearly halved between 2006 and 2021. The percentage of hybrid implants used has gone up by over 2.5 times over the same period. The percentage of uncemented implants used increased from 18% to 44% in the first nine years of the registry, but then steadily declined to 35% over the next seven years, before plateauing. Figure 3.H2 (a) illustrates the temporal changes in fixation and type of primary hip replacements. Figure 3.H2 (b) (page 52) shows dual mobility bearings as a separate group to illustrate their steadily increasing use, which has been most marked in the hybrid fixation group (see Table 3.H2).

Figure 3.H2 (a) Fixation and type by year of primary hip replacement.

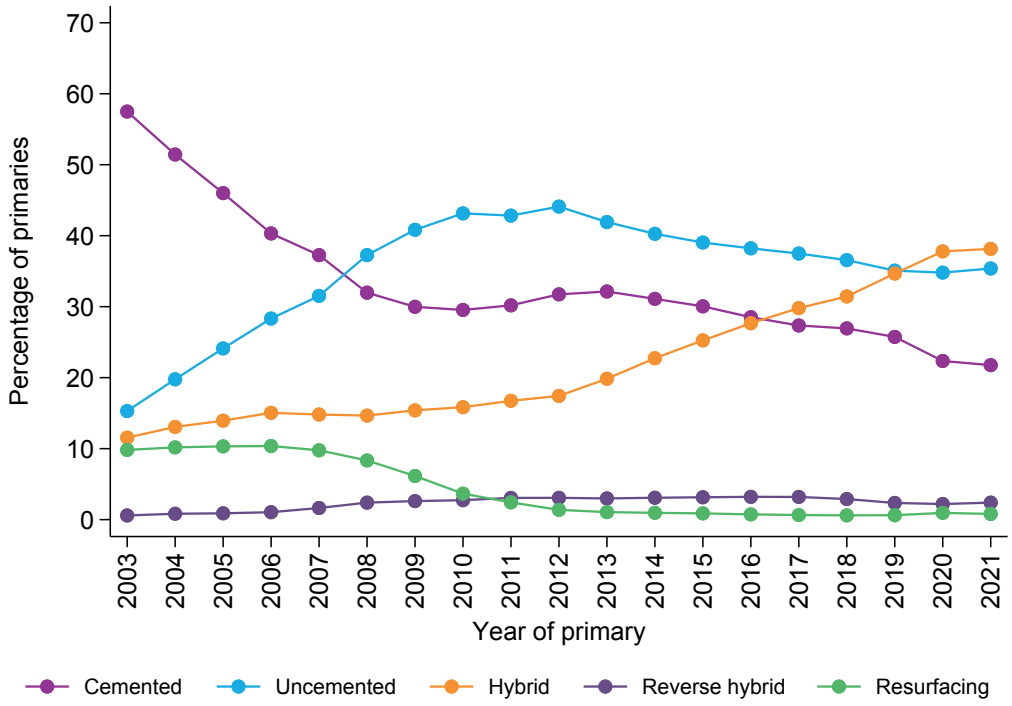


Figure 3.H2 (b) THR fixation and main bearing type by year of primary hip replacement.

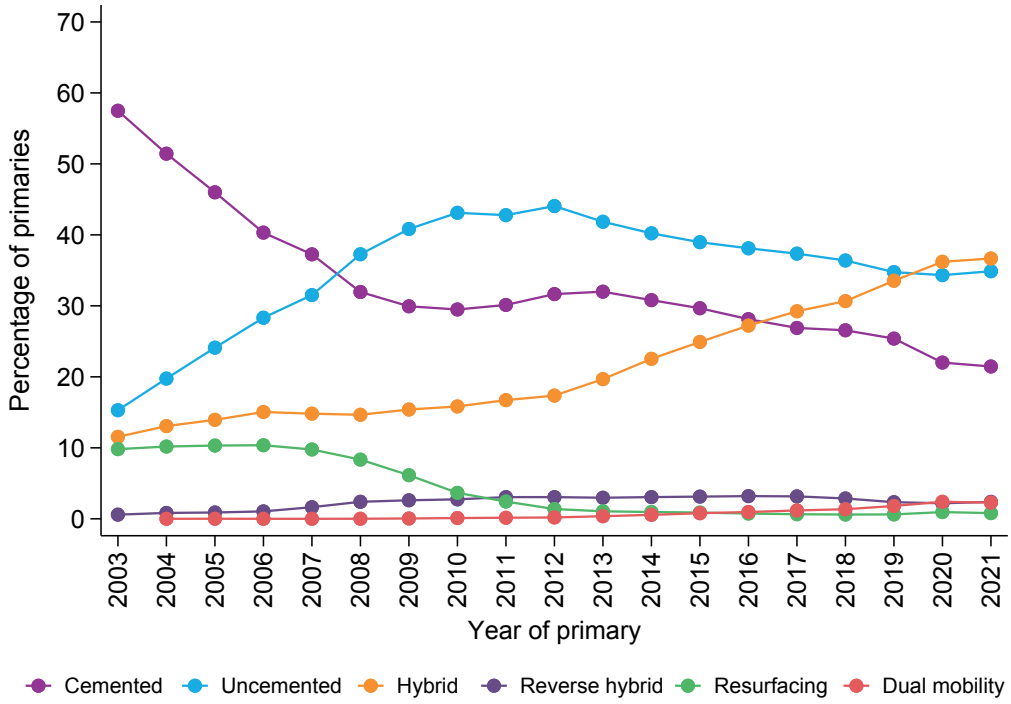
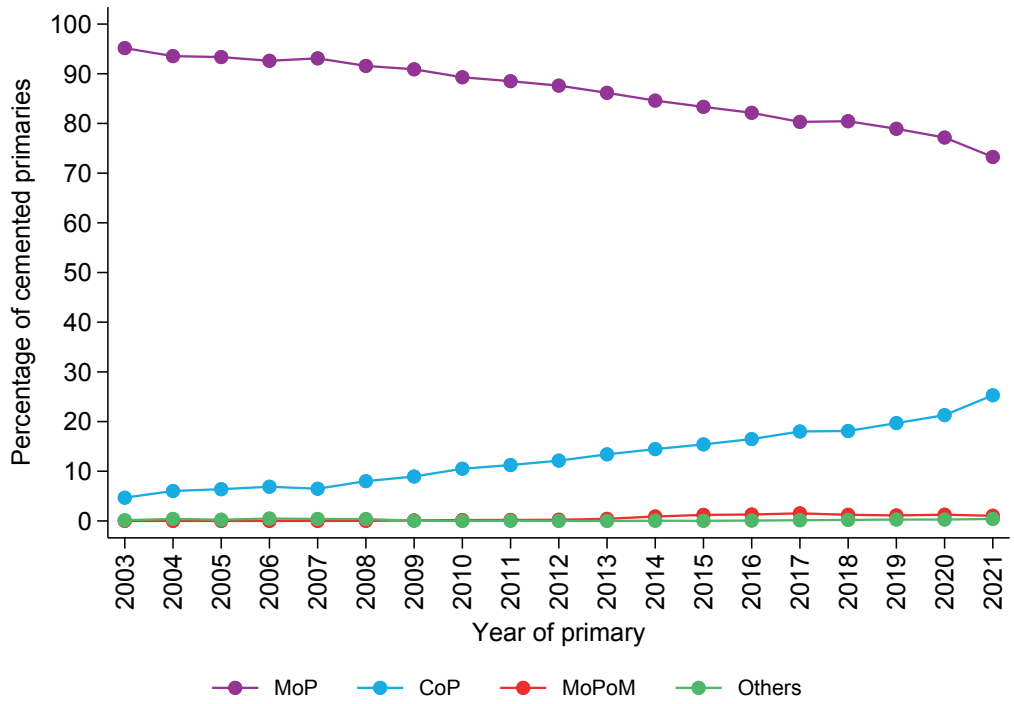


Figure 3.H3 (a) Cemented primary hip replacement bearing surface by year.



Figures 3.H3 (a) to (d) illustrate the temporal changes in the bearing surface combinations used by the type of total hip replacement fixation. Groups that contain more than 500 procedures are plotted separately. Since 2012 there has been a marked increase in the use of ceramic-on-polyethylene bearings and a corresponding decrease in the use of ceramic-on-ceramic bearings. The greatest variation in bearing use is noted in the uncemented fixation group.

Figure 3.H3 (b) Uncemented primary hip replacement bearing surface by year.

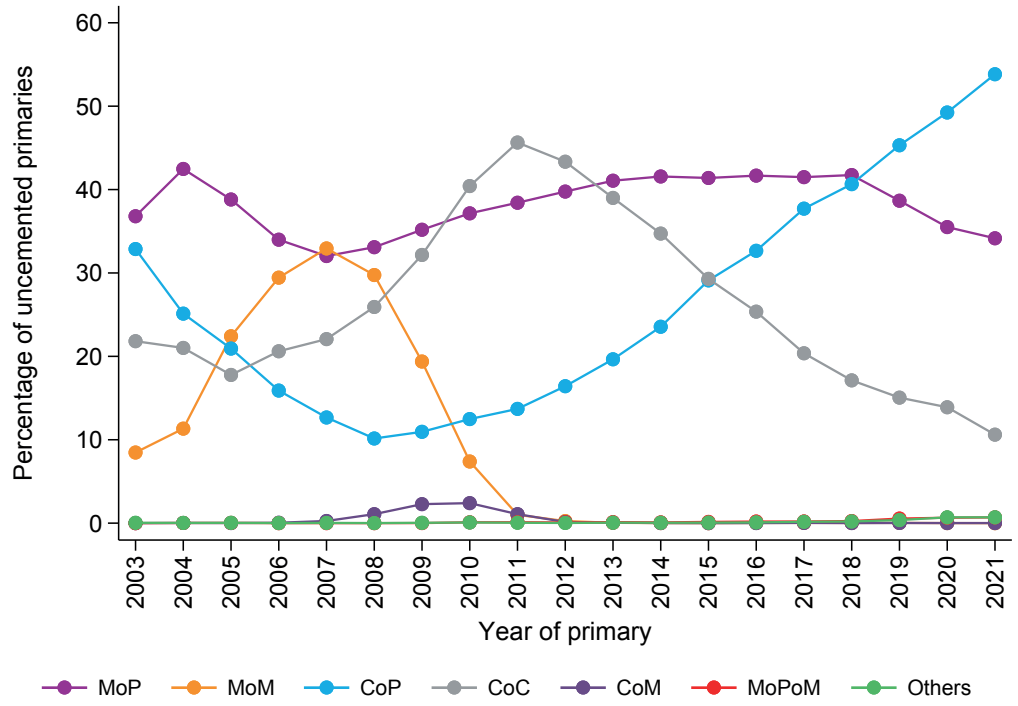


Figure 3.H3 (c) Hybrid primary hip replacement bearing surface by year.

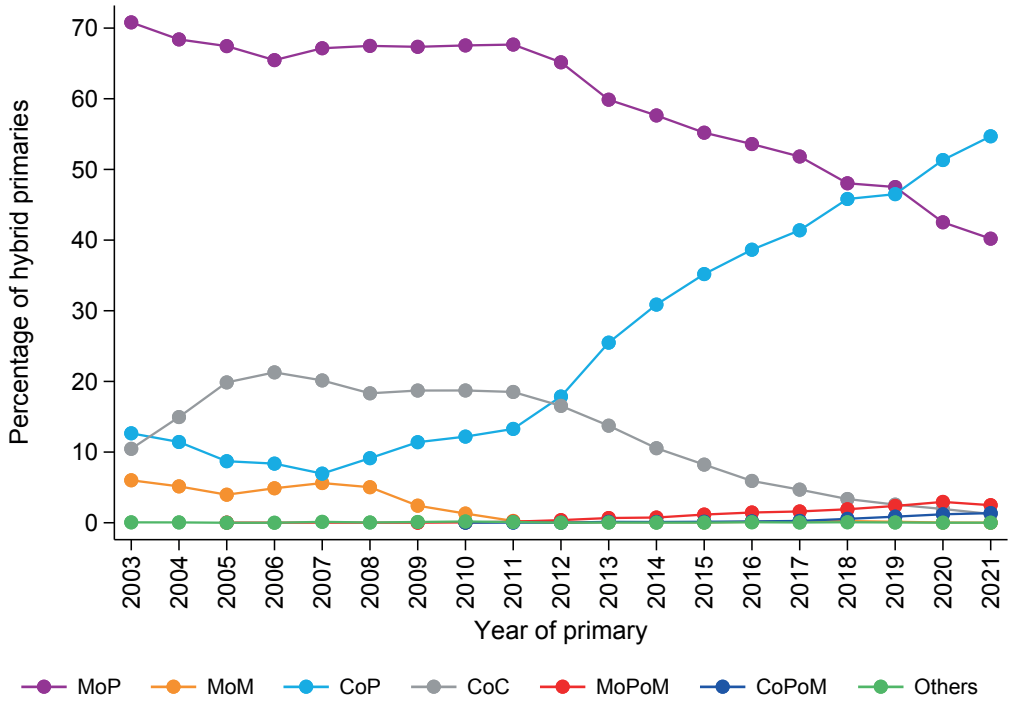


Figure 3.H3 (d) Reverse hybrid primary hip replacement bearing surface by year.

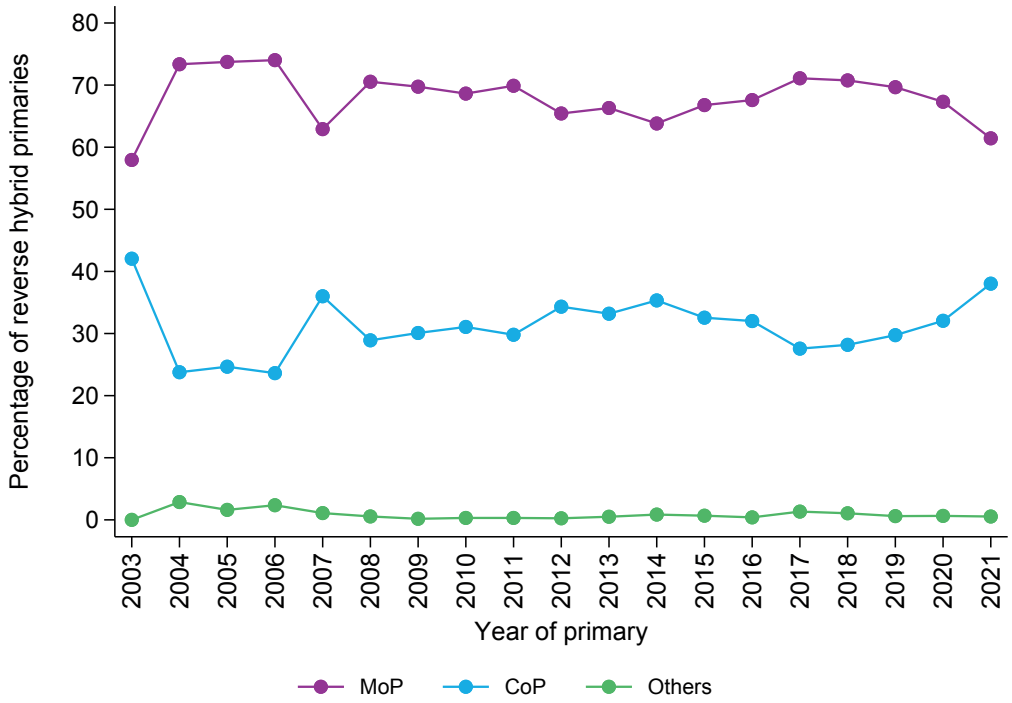
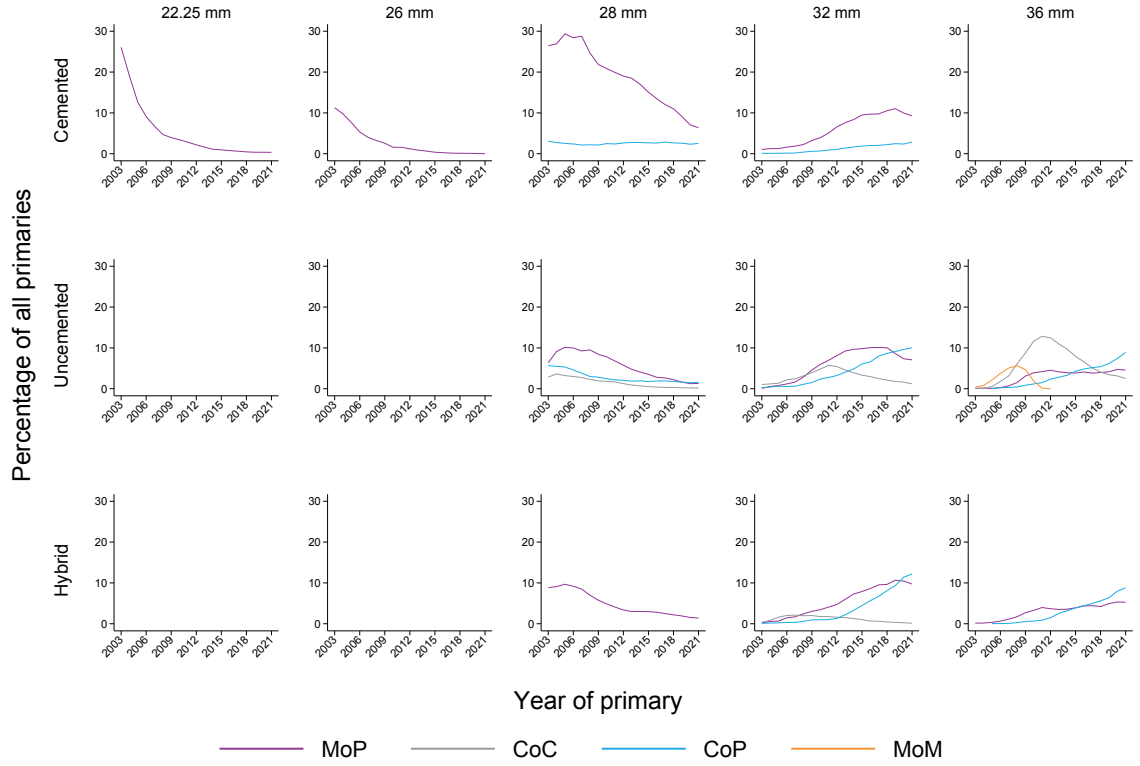


Figure 3.H3 (e) Trends in fixation, bearing and head size in primary unipolar total hip replacement by year.



Note: Only combinations with ≥2% use in any year are plotted.

Figure 3.H3 (e) illustrates the temporal changes in common head sizes, by method of fixation and bearing type in primary unipolar total hip replacement. In 2003, the vast majority of hip replacements utilised heads of 28mm or smaller, across all fixation methods. Since 2003, a progressive shift away from small (22.25mm or 26mm) heads in cemented hip replacements to larger head sizes (>28mm) with alternative fixation methods (uncemented or hybrid) has been observed.

In 2021, as in 2020, the three most common head sizes are 32mm (1st), 36mm (2nd) and 28mm (3rd), with 22.25mm and 26mm rarely being used. The use of ceramic-on-ceramic bearings across all head sizes, but most notably 36mm, has declined since 2011. This decline, conversely, corresponds with an increase in ceramic-on-polyethylene bearings with 32mm heads. The choice of bearing, head size and fixation method was much more heterogeneous in 2021 compared to 2003.

Table 3.H3 provides a breakdown by fixation type and bearing surface, describing the age and gender profile of recipients of primary hip replacements. Patients receiving resurfacing and ceramic-on-ceramic bearings tended to be younger and those receiving metal-on-polyethylene-on-metal dual mobility bearings tended to be older than those in the other groups. Those receiving resurfacings were more likely to be younger males.

Table 3.H3 Age at primary hip replacement by fixation and bearing.

Fixation and bearing surface	N	Age (years)		Male (%)
		Median (IQR*)	Mean (SD)	
All cases	**1,344,357**	**69 (61 to 76)**	**68.1 (11.4)**	**40.2**
All cemented	**412,582**	**74 (68 to 79)**	**73.1 (9.1)**	**33.4**
Cemented and				
MoP	354,609	75 (70 to 80)	74.4 (8.1)	32.8
MoM	424	72 (65 to 78)	71.3 (9.5)	33.5
CoP	54,659	65 (59 to 72)	64.9 (10.4)	37.5
MoPoM	2,574	77 (70 to 83)	75.5 (10.9)	30.4
CoPoM	298	78 (67 to 84)	74.5 (11.6)	28.5
Others	18	49 (45 to 71)	53.8 (16.0)	61.1
All uncemented	**498,529**	**65 (58 to 72)**	**64.4 (11.3)**	**45.2**
Uncemented and				
MoP	192,482	71 (64 to 76)	69.8 (9.6)	41.7
MoM	29,235	63 (57 to 70)	63.0 (11.1)	50.8
CoP	135,302	63 (57 to 70)	62.8 (10.1)	46.7
CoC	137,599	60 (52 to 66)	58.6 (11.3)	47.3
CoM	2,151	63 (56 to 69)	62.1 (10.6)	42.0
MoPoM	983	71 (61 to 79)	69.2 (13.4)	36.2
CoPoM	659	60 (52 to 69)	60.9 (13.0)	56.8
Others	118	62 (52 to 71)	60.8 (13.7)	45.8
All hybrid	**318,261**	**70 (63 to 77)**	**69.2 (10.9)**	**37.3**
Hybrid and				
MoP	173,224	74 (68 to 79)	73.3 (8.6)	34.8
MoM	2,605	64 (56 to 73)	64.3 (12.3)	46.4
CoP	109,061	66 (59 to 72)	65.3 (10.6)	40.4
CoC	27,573	60 (53 to 66)	59.1 (11.3)	40.8
MoPoM	4,285	75 (68 to 82)	73.8 (11.1)	32.9
CoPoM	1,364	70 (60 to 78)	68.5 (12.6)	43.4
Others	149	68 (59 to 75)	66.0 (13.1)	47.7
All reverse hybrid	**34,797**	**70 (64 to 77)**	**69.7 (9.8)**	**37.1**
Reverse hybrid and				
MoP	23,602	73 (68 to 78)	72.8 (8.0)	35.8
CoP	10,958	64 (58 to 69)	63.0 (9.6)	40.0
Others	237	73 (58 to 81)	68.4 (15.5)	31.2
All resurfacing	**41,428**	**55 (48 to 60)**	**53.9 (9.2)**	**73.6**
Resurfacing and				
MoM	41,121	55 (48 to 60)	53.9 (9.2)	73.8
Others	307	54 (48 to 61)	53.7 (10.3)	58.0
Unconfirmed	**38,760**	**69 (61 to 77)**	**68.1 (12.5)**	**38.6**

*IQR=interquartile range.

Table 3.H4 Primary hip replacement patient demographics.

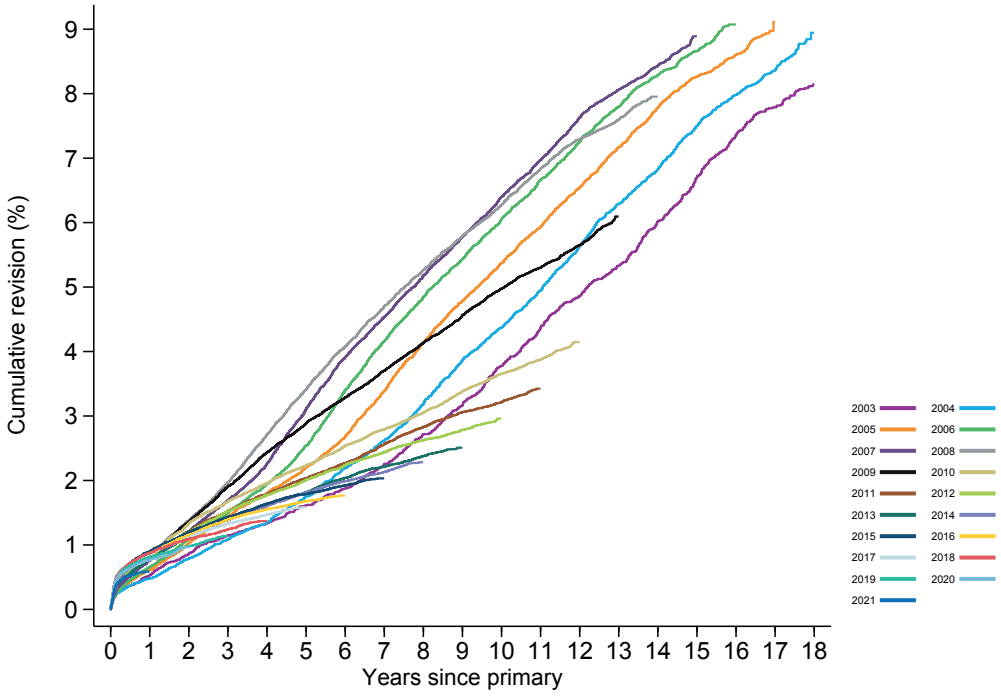
		Male N (%)		Female N (%)		All N (%)
Total		**540,025**		**804,332**		**1,344,357**
ASA 1		95,495 (17.7)		110,435 (13.7)		205,930 (15.3)
ASA 2		351,284 (65.0)		557,623 (69.3)		908,907 (67.6)
ASA 3		89,629 (16.6)		131,972 (16.4)		221,601 (16.5)
ASA 4		3,551 (0.7)		4,209 (0.5)		7,760 (0.6)
ASA 5		66 (<0.1)		93 (<0.1)		159 (<0.1)
Osteoarthritis as the sole reason for primary		483,427 (89.5)		700,033 (87.0)		1,183,460 (88.0)
Osteoarthritis as a reason for primary		499,720 (92.5)		726,970 (90.4)		1,226,690 (91.2)
Age	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
	66.6 (11.6)	68 (59 to 75)	69.2 (11.1)	70 (63 to 77)	68.1 (11.4)	69 (61 to 76)

Table 3.H4 shows the American Society of Anesthesiologists (ASA) grade and indication for primary hip replacement by gender. A greater number of females than males undergo primary hip replacement and two-thirds of patients are ASA grade 2. Only a small number of patients with a grade greater than ASA 3 undergo a primary hip replacement. The majority of cases are performed for osteoarthritis. A total of 1,183,460 (88.0%) primary hip replacements have been recorded in the registry where the sole indication was osteoarthritis.

3.2.2 First revisions after primary hip surgery

A total of 40,387 first revisions of a hip replacement have been linked to a previous primary hip replacement recorded in the registry between 2003 and 2021. Figures 3.H4 (a) and (b) (page 61) illustrate temporal changes in the overall revision rates using Kaplan-Meier estimates; procedures have been grouped by the year of the primary operation. Figure 3.H4 (a) plots each Kaplan-Meier survival curve with a common origin, i.e. time zero is equal to the year of operation. This illustrates that revision rates increased between 2003 and 2007/8 and then declined between 2007/8 and 2021.

Figure 3.H4 (a) KM estimates of cumulative revision by year, in primary hip replacements.



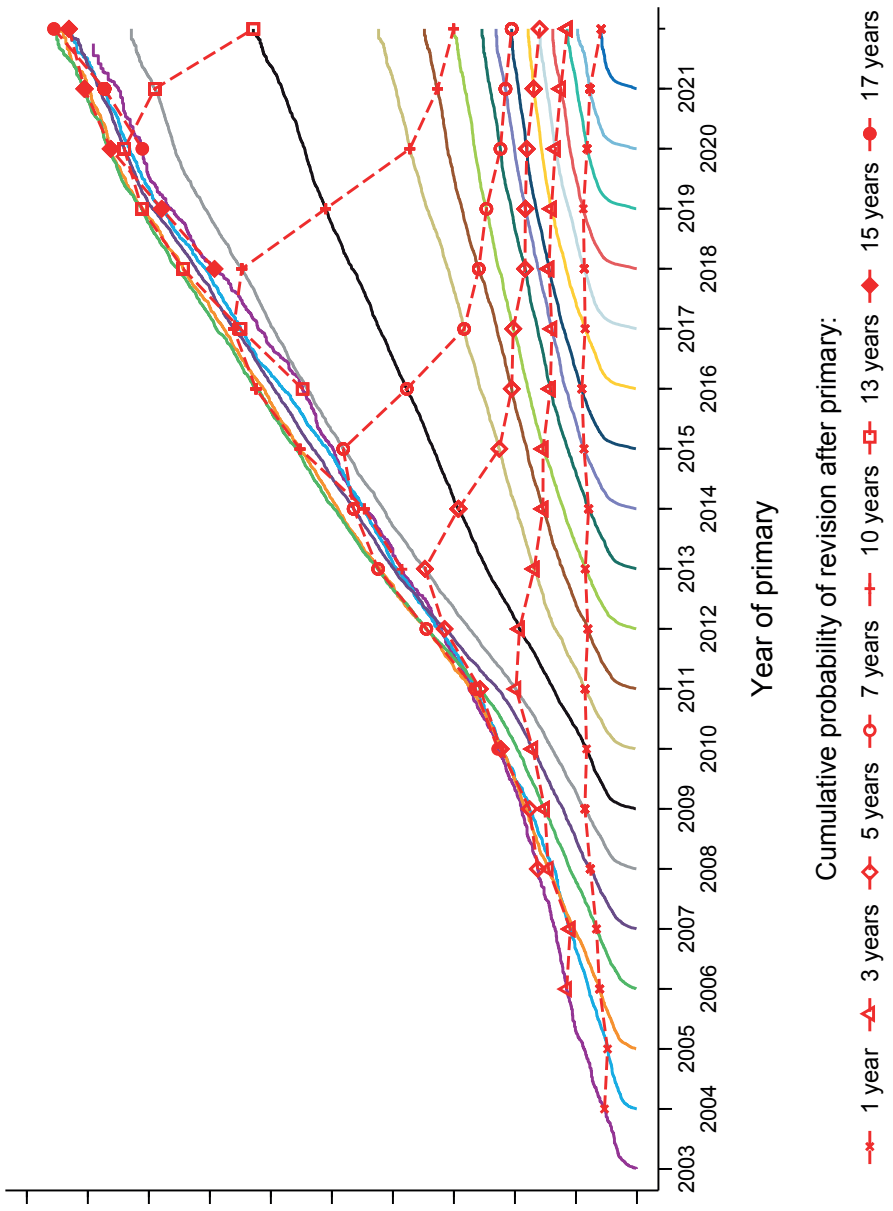


Figure 3.H4 (b) KM estimates of cumulative revision by year, in primary hip replacements plotted by year of primary.

Figure 3.H4 (b) shows the same curves plotted against calendar time, where the origin of each curve is the year of operation. In addition, we have highlighted the revision rate at 1, 3, 5, 7, 10, 13, 15 and 17 years. Figure 3.H4 (b) separates each year, enabling changes in revision estimates over time to be clearly identified. If revision surgery and timing of revision surgery were static across time, it would be expected that all the revision curves would be the same shape and equally spaced; departures from this indicate a change in the number and timing of revision procedures. It is also very clear that the 3, 5, 7, 10 and 13-year rate of revision increases for operations occurring between 2003 and 2008 and then reduces for operations occurring between 2008 and 2021. The early increases may be partly a result of under-reporting in the earlier years of the registry as this wasn't mandatory at that time but is also contributed to by the usage of metal-on-metal bearings, which peaked in 2008 and then fell (see Table 3.H2 on page 49).

A similar pattern, although smaller in effect, is also observed in knees. Knees were not affected by the high revision rates of metal-on-metal bearings, and thus the decreases observed since 2009 indicate a broader improvement in revision outcomes overall. It appears that this secular decline in revision rate is still ongoing. This improvement suggests the adoption of evidence-based practice to which the NJR's clinician feedback has contributed. For example, for a primary hip replacement performed in 2010, the 10-year revision estimate is 3.7% (95% CI 3.5-3.8) which is below the current NICE recommended threshold of 5% at ten years (NICE: Total hip replacement and resurfacing arthroplasty for end-stage arthritis of the hip. Technology appraisal guidance [TA304] Published: 26 February 2014). Prior to 2014, the revision threshold recommended by NICE was 10% at ten years (NICE: Guidance on the Selection of Prostheses for Primary Total Hip Replacement. Technology appraisal guidance [TA2] Published: 26 April 2000).

Table 3.H5 (page 63) provides Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any cause, firstly for all cases combined and then by type of fixation and by bearing surface within each fixation group. The table shows updated estimates at 1, 3, 5, 10, 15 and 18 years from the primary operation together with 95% Confidence Intervals (95% CI). Estimates in blue italics indicate time points where fewer than 250 cases remained at risk, meaning that the estimates are less reliable. Kaplan-Meier estimates are not shown at all when the numbers at risk fell below ten cases.

Further revisions in the blue italicised groups would be highly unlikely and, when they do occur, they may appear to have a disproportionate impact on the Kaplan-Meier estimate, i.e. the step upwards may seem disproportionately large. Furthermore, the upper 95% CI at these time points may be underestimated. Although a number of statistical methods have been proposed to deal with this, they typically give different values and, as yet, there is no clear consensus for the large datasets presented here.

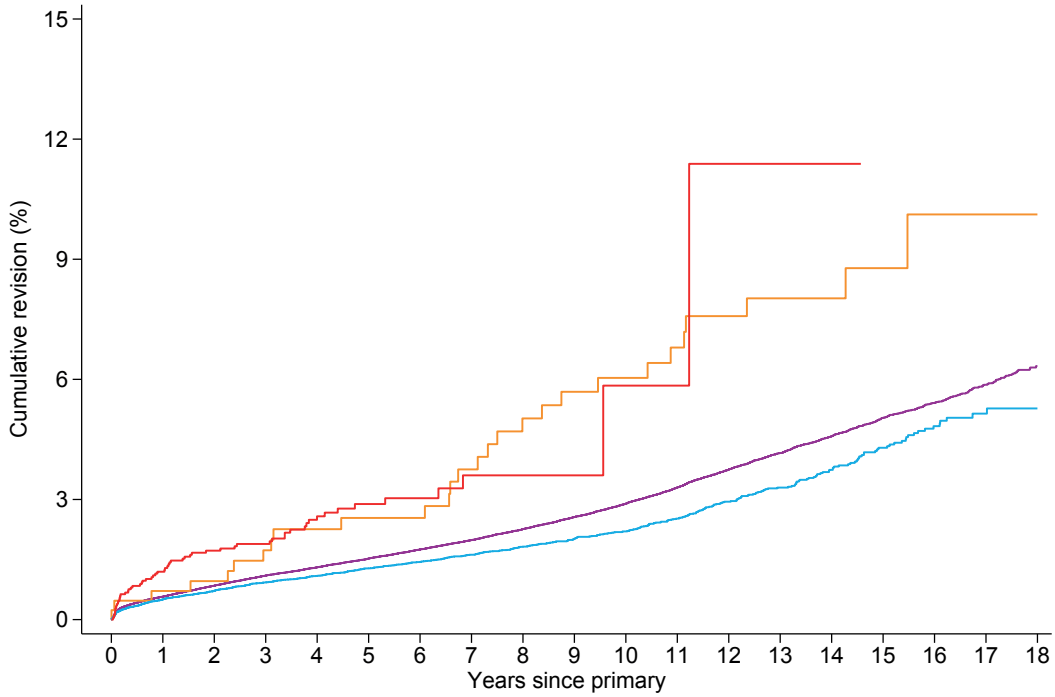
The revision rate of metal-on-polyethylene-on-metal dual mobility bearings appears higher up to five years across all fixation types than that of most of the unipolar bearing combinations, except metal-on-metal. The ceramic-on-polyethylene-on-metal dual mobility bearings show lower revision estimates than the metal-on-polyethylene-on-metal combinations but with overlapping confidence intervals. The relatively small numbers at risk in the dual mobility groups make it difficult to draw firm conclusions yet.

Table 3.H5 KM estimates of cumulative revision (95% CI) by fixation and bearing, in primary hip replacements. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Fixation and bearing surface	N	Time since primary					
		1 year	3 years	5 years	10 years	15 years	18 years
All cases*	**1,344,357**	**0.80 (0.79-0.82)**	**1.46 (1.44-1.48)**	**2.09 (2.07-2.12)**	**4.05 (4.00-4.09)**	**6.50 (6.41-6.59)**	**7.81 (7.65-7.98)**
All cemented	**412,582**	**0.57 (0.55-0.59)**	**1.08 (1.05-1.12)**	**1.50 (1.46-1.54)**	**2.83 (2.76-2.90)**	**4.97 (4.83-5.11)**	**6.24 (5.98-6.51)**
MoP	354,609	0.57 (0.55-0.60)	1.10 (1.06-1.13)	1.52 (1.48-1.57)	2.89 (2.82-2.97)	5.04 (4.89-5.19)	6.33 (6.06-6.62)
MoM	424	0.72 (0.23-2.20)	1.73 (0.83-3.60)	2.54 (1.37-4.67)	6.04 (3.96-9.14)	*8.78 (5.99-12.78)*	
CoP	54,659	0.50 (0.45-0.57)	0.93 (0.85-1.02)	1.28 (1.18-1.39)	2.20 (2.04-2.38)	4.29 (3.88-4.75)	*5.27 (4.64-5.99)*
MoPoM	2,574	*1.20 (0.83-1.72)*	*1.89 (1.40-2.54)*	2.89 (2.19-3.80)	*5.84 (2.69-12.44)*		
CoPoM	298	*0.75 (0.19-2.99)*	*1.26 (0.40-3.92)*	*1.26 (0.40-3.92)*			
Others	18**	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*			
All uncemented	**498,529**	**0.94 (0.91-0.97)**	**1.70 (1.66-1.74)**	**2.44 (2.39-2.49)**	**4.71 (4.63-4.79)**	**7.38 (7.22-7.54)**	**8.92 (8.55-9.31)**
MoP	192,482	1.01 (0.97-1.06)	1.60 (1.55-1.66)	2.01 (1.95-2.08)	3.44 (3.33-3.55)	5.93 (5.67-6.21)	7.91 (7.15-8.74)
MoM	29,235	1.06 (0.95-1.18)	3.48 (3.27-3.69)	7.69 (7.38-8.00)	17.71 (17.26-18.17)	22.49 (21.94-23.05)	*24.07 (23.12-25.05)*
CoP	135,302	0.80 (0.75-0.85)	1.31 (1.25-1.38)	1.69 (1.61-1.76)	2.69 (2.56-2.83)	4.17 (3.89-4.48)	5.13 (4.64-5.66)
CoC	137,599	0.95 (0.90-1.00)	1.73 (1.66-1.80)	2.23 (2.15-2.32)	3.36 (3.25-3.47)	4.81 (4.59-5.05)	6.33 (5.56-7.20)
CoM	2,151	0.56 (0.32-0.98)	2.74 (2.12-3.53)	4.79 (3.95-5.80)	8.16 (7.05-9.45)		
MoPoM	983	2.67 (1.81-3.92)	3.34 (2.31-4.81)	*3.62 (2.50-5.24)*	*3.62 (2.50-5.24)*		
CoPoM	659	0.64 (0.24-1.69)	*2.26 (1.05-4.83)*	*2.26 (1.05-4.83)*			
Others	118**	*3.39 (1.29-8.78)*	*6.89 (3.50-13.30)*	*7.82 (4.14-14.50)*	*16.01 (9.73-25.73)*		
All hybrid	**318,261**	**0.79 (0.76-0.82)**	**1.28 (1.24-1.32)**	**1.72 (1.67-1.77)**	**3.04 (2.95-3.13)**	**4.77 (4.58-4.96)**	**5.96 (5.55-6.40)**
MoP	173,224	0.84 (0.79-0.88)	1.34 (1.28-1.39)	1.77 (1.70-1.84)	3.00 (2.88-3.11)	4.65 (4.42-4.90)	5.60 (5.14-6.11)
MoM	2,605	0.81 (0.53-1.24)	2.68 (2.12-3.39)	5.80 (4.93-6.81)	15.71 (14.24-17.32)	20.98 (19.17-22.94)	*23.09 (20.61-25.82)*
CoP	109,061	0.75 (0.70-0.80)	1.18 (1.11-1.25)	1.48 (1.40-1.57)	2.26 (2.11-2.44)	3.75 (3.26-4.31)	*5.50 (4.28-7.05)*
CoC	27,573	0.60 (0.52-0.70)	1.09 (0.97-1.22)	1.58 (1.44-1.74)	2.67 (2.46-2.89)	3.94 (3.61-4.29)	*5.21 (4.22-6.41)*
MoPoM	4,285	1.20 (0.91-1.59)	1.68 (1.30-2.18)	1.93 (1.47-2.52)	*1.93 (1.47-2.52)*		
CoPoM	1,364	0.88 (0.49-1.60)	1.44 (0.81-2.56)	*1.79 (0.98-3.24)*			
Others	149**	*2.02 (0.66-6.14)*	*2.78 (1.05-7.25)*	*2.78 (1.05-7.25)*	*2.78 (1.05-7.25)*		
All reverse hybrid	**34,797**	**0.84 (0.75-0.95)**	**1.45 (1.32-1.59)**	**1.93 (1.78-2.09)**	**3.30 (3.04-3.58)**	**5.88 (5.13-6.75)**	*6.57 (5.52-7.82)*
MoP	23,602	0.87 (0.75-0.99)	1.44 (1.29-1.61)	1.89 (1.71-2.09)	3.41 (3.08-3.77)	6.07 (5.12-7.19)	*6.89 (5.49-8.63)*
CoP	10,958	0.76 (0.61-0.95)	1.44 (1.23-1.69)	1.90 (1.65-2.20)	2.90 (2.52-3.35)	*5.22 (4.08-6.68)*	*5.75 (4.32-7.65)*
Others	237**	*2.23 (0.93-5.29)*	*2.82 (1.27-6.19)*	*8.45 (4.87-14.45)*	*17.03 (10.65-26.62)*	*21.40 (12.50-35.22)*	
All resurfacing	**41,428**	**1.18 (1.08-1.29)**	**2.92 (2.76-3.08)**	**5.10 (4.89-5.32)**	**10.18 (9.88-10.49)**	**13.51 (13.14-13.89)**	**14.69 (14.22-15.18)**
MoM	41,121	1.18 (1.08-1.29)	2.91 (2.75-3.08)	5.10 (4.89-5.33)	10.19 (9.88-10.50)	13.51 (13.14-13.90)	14.69 (14.22-15.18)
Others	307	*1.58 (0.59-4.19)*	*2.81 (1.24-6.31)*				

*Includes 38,760 with unconfirmed fixation/bearing surface; ** Wide CI because estimates are based on a small group size.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

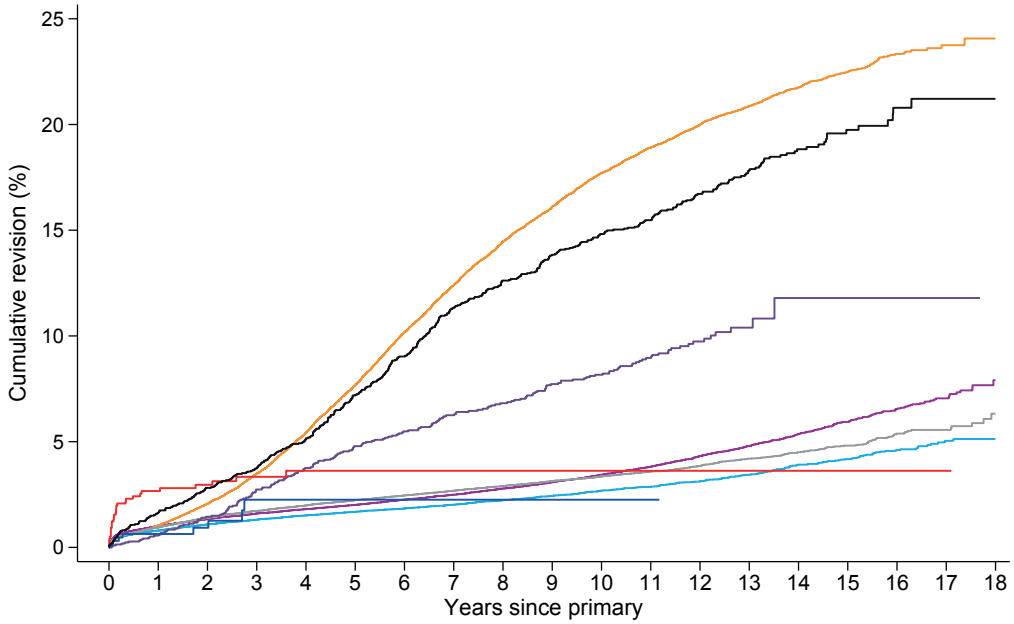
Figure 3.H5 KM estimates of cumulative revision in cemented primary hip replacements by bearing.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk									
MoP	354,609	314,002	256,673	199,188	144,392	97,577	62,258	35,055	14,940	2,504
MoM	424	395	355	329	293	260	*217*	*143*	*43*	*<4*
CoP	54,659	46,030	35,368	25,711	17,466	11,008	6,509	3,491	1,491	*195*
MoPoM	2,574	1,866	1,124	477	*117*	*33*	*9*	*<4*		

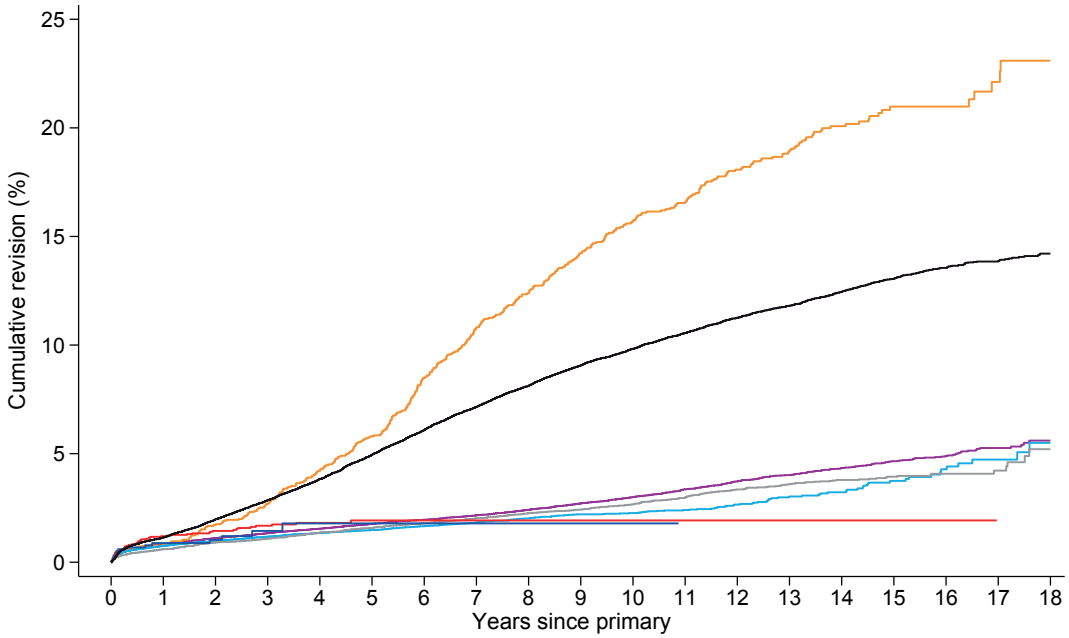
Figures 3.H5 to 3.H8 (pages 64 to 67) illustrate the differences between the various bearing surface sub-groups for cemented, uncemented, hybrid and reverse hybrid hips, respectively. Metal-on-metal bearings continue to perform worse than all other options regardless of fixation, apart from in cemented fixation where the results of the rarely used metal-on-metal combination are similar to metal-on-polyethylene-on-metal dual mobility. The revision rates for ceramic-on-polyethylene bearings remain consistently low or equivalent to alternatives across all fixation options out to 15 years and it is encouraging that these are becoming more widely used with time. The trajectory of the revision rates for polyethylene-containing bearings does appear to differ beyond ten years, which may represent the increased use of highly cross-linked polyethylene over time. The long-term impacts of such changes will continue to be monitored. Dual mobility bearings have higher early revision rates than other options (not including metal-on-metal) for cemented and uncemented fixation, this effect appears to persist in cemented fixation. Although a similar pattern is seen in hybrid fixation, the difference compared to alternatives is smaller. Given the relatively small numbers and the likely case mix selection, these patterns should continue to be monitored.

Figure 3.H6 KM estimates of cumulative revision in uncemented primary hip replacements by bearing.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk									
MoP	192,482	167,908	133,641	99,248	67,793	41,599	22,279	9,687	3,359	352
MoM	29,235	28,056	26,296	24,021	21,809	19,643	16,080	7,485	1,622	*84*
CoP	135,302	106,717	74,850	48,748	30,147	18,135	10,521	5,875	2,513	407
CoC	137,599	128,486	114,838	96,399	72,723	45,450	21,321	8,193	2,497	319
CoM	2,151	2,087	1,978	1,874	1,789	1,608	710	*38*	*<4*	
MoPoM	983	585	315	*179*	*103*	*48*	*<4*	*<4*	*<4*	
CoPoM	659	297	*102*	*30*	*13*	*<4*				
Resurfacing	2,837	2,642	2,494	2,364	2,251	2,032	1,608	834	257	*17*

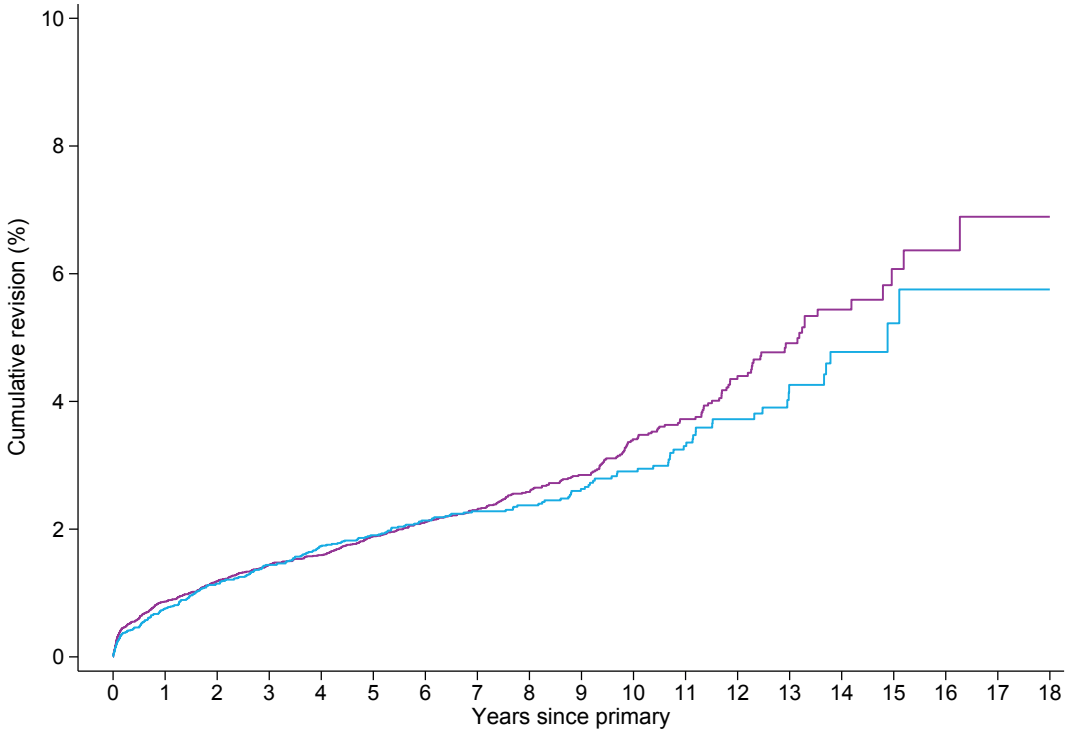
Figure 3.H7 KM estimates of cumulative revision in hybrid primary hip replacements by bearing.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk									
MoP	173,224	143,588	106,890	74,480	49,580	31,800	18,794	9,565	3,568	508
MoM	2,605	2,478	2,204	1,949	1,752	1,546	1,303	797	294	*56*
CoP	109,061	78,240	47,334	25,456	12,060	6,125	3,458	1,690	745	*123*
CoC	27,573	26,192	23,786	20,496	16,319	11,823	7,633	4,268	1,515	*133*
MoPoM	4,285	2,560	1,130	413	*116*	*19*	*<4*	*<4*	*<4*	
CoPoM	1,364	620	*181*	*64*	*21*	*<4*				
Resurfacing	38,587	36,562	34,505	32,158	29,566	26,954	22,486	14,462	6,235	1,059

Figure 3.H8 illustrates the revision rate of metal-on-polyethylene and ceramic-on-polyethylene bearings used with reverse hybrid fixation in primary total hip replacement. Revision rates are similar for the first seven years, but after this there is a suggestion that outcomes are beginning to diverge with ceramic-on-polyethylene having slightly lower revision estimates. However, more data will be needed to ascertain if this trend represents a meaningful difference.

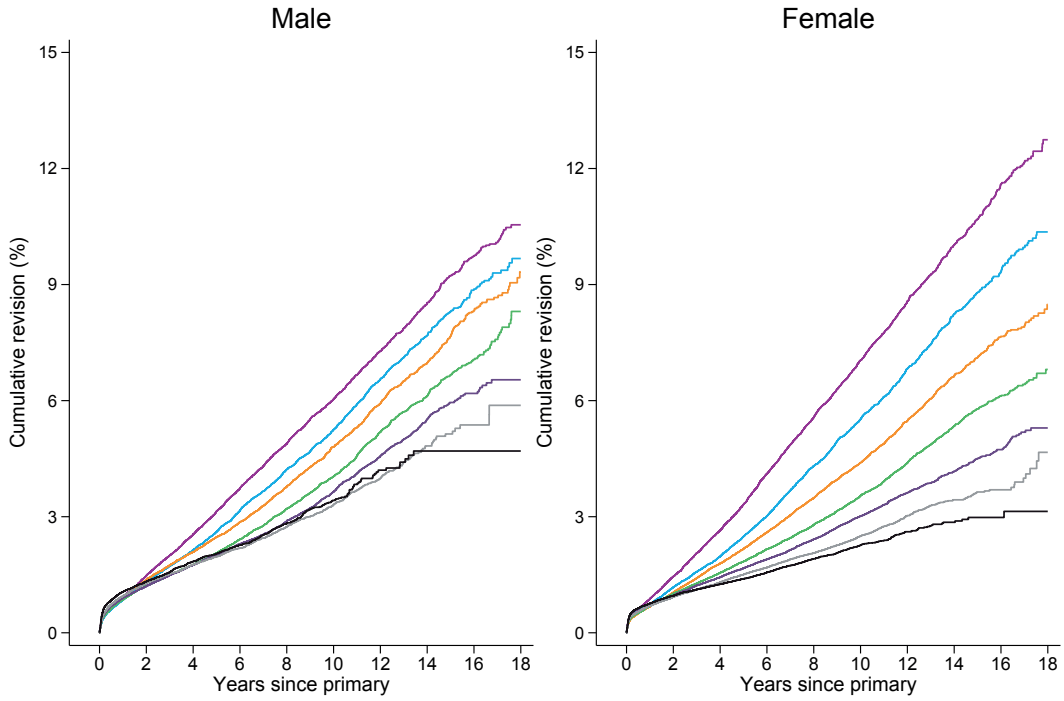
Figure 3.H8 KM estimates of cumulative revision in reverse hybrid primary hip replacements by bearing.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk									
MoP	23,602	20,445	15,934	11,084	7,260	4,291	2,032	686	*214*	*18*
CoP	10,958	9,502	7,788	5,831	3,892	2,347	1,236	455	*114*	*19*

In Figure 3.H9 (a), the whole cohort (including those with metal-on-metal bearings) has been sub-divided by age at primary operation and by gender. Across the whole group, there was an inverse relationship between the probability of revision and the age of the patient. A closer look at both genders (Figure 3.H9 (a)) shows that the variation between the age groups was greater in females than in males. Thus, for example, females under 55 years had higher revision rates than their male counterparts in the same age band, whereas females aged 80 years and older had a lower revision rate than their male counterparts.

Figure 3.H9 (a) KM estimates of cumulative revision in all primary hip replacements by gender and age.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



In Figure 3.H9 (b), primary total hip replacements with metal-on-metal (or unconfirmed) bearing surfaces and resurfacings have been excluded. The revision rates for the younger females are noticeably lower compared to the data in Figure 3.H9 (a) which includes metal-on-metal bearings; an age trend is seen in both genders but rates for females are lower than for males across the entire age spectrum. The age-mediated disparity in revision rates for females appears to be increasing with longer follow-up.

Figure 3.H9 (b) KM estimates of cumulative revision in all primary hip replacements by gender and age, excluding metal-on-metal hip replacement, unclassified replacements, and resurfacing. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

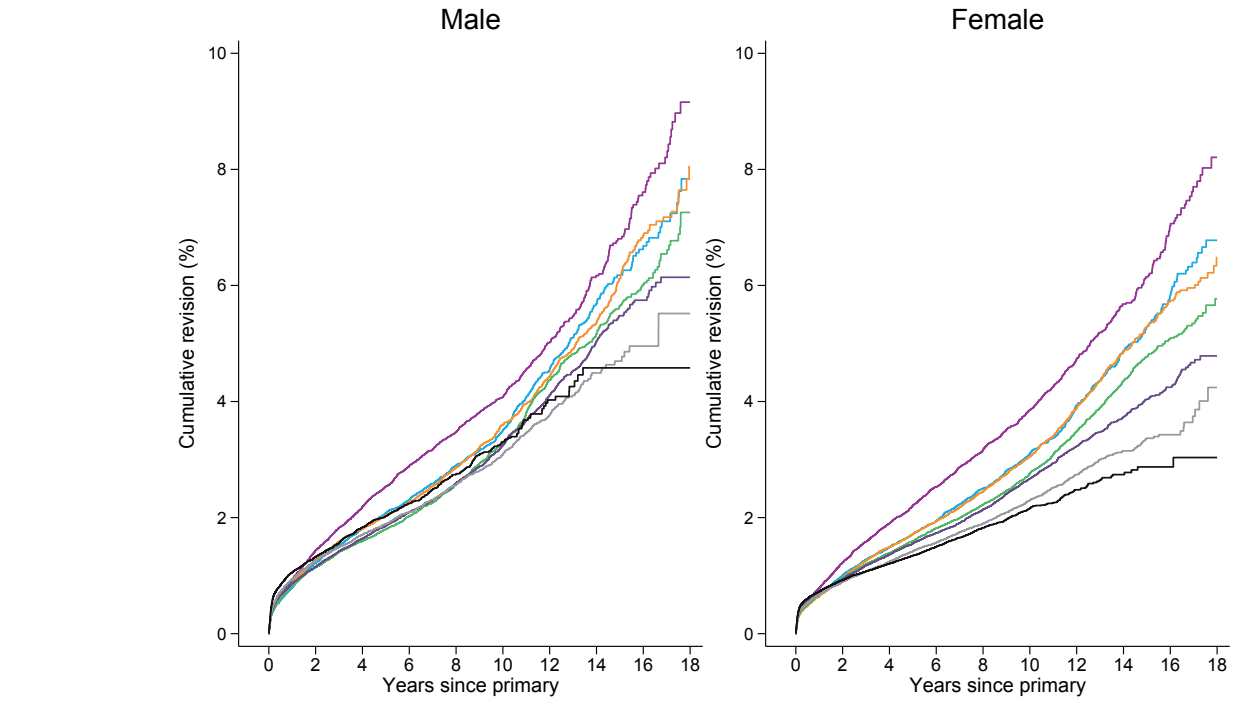


Table 3.H6 (page 70) further expands Table 3.H5 (page 63) to show separate estimates for males and females within each of four age bands, <55, 55 to 64, 65 to 74 and ≥75 years. Estimates are shown at 1, 3, 5, 10, 15 and 18 years after the primary operation. These estimates refine results shown in earlier reports, but now with larger numbers of cases and therefore generally narrower confidence intervals. The relatively good results obtained with ceramic-on-ceramic and ceramic-on-polyethylene bearings in younger patients are striking. Resurfacing hip replacement continues to show high revision rates in all groups, especially females. Even in males under 55 years of age, resurfacing has twice the revision rate of some alternatives out to 15 years. Dual mobility age and gender sub-groups are too small at this stage to provide firm conclusions on relative revision rates.

Table 3.H6 KM estimates of cumulative revision (95% CI) of primary hip replacements by gender, age group, fixation and bearing. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Fixation and bearing surface	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
All cases	<55	80,138	0.91 (0.85-0.98)	2.00 (1.90-2.11)	3.14 (3.01-3.27)	6.04 (5.84-6.26)	9.23 (8.88-9.58)	10.54 (10.03-11.09)	80,699	0.88 (0.82-0.95)	2.06 (1.96-2.16)	3.32 (3.18-3.45)	7.04 (6.82-7.28)	10.69 (10.31-11.08)	12.74 (12.09-13.43)
All cemented	<55	5,534	0.76 (0.56-1.03)	1.76 (1.44-2.16)	2.41 (2.01-2.88)	4.32 (3.68-5.08)	8.47 (7.15-10.01)	*12.22 (10.00-14.88)*	8,608	0.67 (0.51-0.87)	1.44 (1.20-1.73)	2.11 (1.80-2.46)	4.31 (3.78-4.91)	8.00 (6.94-9.20)	*9.72 (8.26-11.44)*
MoP	<55	2,201	0.97 (0.64-1.49)	2.33 (1.77-3.08)	3.10 (2.42-3.95)	5.56 (4.52-6.84)	11.05 (9.11-13.37)	*15.38 (12.41-18.96)*	3,836	0.85 (0.61-1.21)	1.84 (1.45-2.34)	2.49 (2.02-3.07)	5.19 (4.40-6.12)	9.08 (7.72-10.66)	*11.22 (9.33-13.46)*
MoM	<55	7							12			*0.00 (.-.)*			
CoP	<55	3,268	0.60 (0.38-0.93)	1.37 (1.01-1.86)	1.93 (1.48-2.51)	3.24 (2.52-4.15)	*5.25 (3.83-7.18)*	*7.21 (4.92-10.51)*	4,659	0.46 (0.30-0.71)	1.05 (0.78-1.40)	1.71 (1.35-2.18)	3.32 (2.67-4.12)	*6.70 (5.05-8.86)*	*7.28 (5.38-9.83)*
MoPoM	<55	42	*2.44 (0.35-16.08)*	*2.44 (0.35-16.08)*	*2.44 (0.35-16.08)*				83	*4.32 (1.41-12.87)*	*5.97 (2.27-15.21)*	*8.32 (3.46-19.28)*			
All uncemented	<55	43,482	0.94 (0.85-1.04)	2.07 (1.93-2.21)	3.20 (3.02-3.39)	6.12 (5.82-6.43)	9.55 (8.96-10.18)	*10.69 (9.83-11.62)*	45,544	0.88 (0.80-0.97)	1.95 (1.82-2.08)	3.05 (2.88-3.22)	6.00 (5.72-6.30)	9.05 (8.53-9.59)	*12.06 (10.66-13.62)*
MoP	<55	5,621	0.93 (0.71-1.23)	1.79 (1.46-2.19)	2.53 (2.11-3.03)	4.31 (3.64-5.10)	7.40 (5.97-9.16)	*9.62 (6.99-13.15)*	6,734	0.93 (0.72-1.19)	1.75 (1.45-2.11)	2.45 (2.07-2.88)	4.10 (3.50-4.81)	7.48 (6.13-9.12)	*11.79 (8.71-15.88)*
MoM	<55	3,333	0.75 (0.51-1.11)	3.58 (3.00-4.27)	7.70 (6.84-8.67)	17.58 (16.31-18.94)	22.75 (21.20-24.39)	*23.49 (21.74-25.35)*	2,400	1.84 (1.37-2.46)	5.83 (4.96-6.85)	12.73 (11.45-14.14)	26.73 (24.99-28.57)	32.79 (30.84-34.82)	*35.38 (31.86-39.17)*
CoP	<55	12,902	0.93 (0.78-1.12)	1.69 (1.47-1.95)	2.35 (2.06-2.68)	3.41 (2.92-3.98)	5.13 (4.00-6.57)	*6.30 (4.71-8.39)*	13,148	0.85 (0.70-1.02)	1.45 (1.25-1.68)	1.96 (1.71-2.26)	3.24 (2.76-3.81)	5.98 (4.76-7.52)	*9.64 (6.92-13.35)*
CoC	<55	21,258	0.98 (0.86-1.12)	2.04 (1.86-2.25)	2.84 (2.62-3.09)	4.27 (3.96-4.60)	6.40 (5.64-7.25)	*7.29 (6.25-8.49)*	22,806	0.78 (0.68-0.91)	1.74 (1.58-1.93)	2.40 (2.20-2.61)	4.03 (3.74-4.35)	4.99 (4.56-5.47)	*7.31 (5.20-10.24)*
CoM	<55	195	*1.03 (0.26-4.04)*	*4.63 (2.44-8.72)*	*7.85 (4.81-12.69)*	*12.31 (8.35-17.96)*			268		*4.91 (2.88-8.30)*	*8.73 (5.89-12.85)*	*12.25 (8.83-16.88)*		
MoPoM	<55	49	*2.13 (0.30-14.16)*	*2.13 (0.30-14.16)*	*5.89 (1.42-22.68)*				86	*1.18 (0.17-8.06)*	*1.18 (0.17-8.06)*	*1.18 (0.17-8.06)*			
CoPoM	<55	108	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*				84	*1.22 (0.17-8.34)*	*6.58 (2.02-20.34)*				
Others	<55	16	*0.00 (.-.)*	*6.67 (0.97-38.74)*	*6.67 (0.97-38.74)*				18	*5.56 (0.80-33.36)*	*11.46 (2.99-38.61)*	*11.46 (2.99-38.61)*	*24.11 (9.76-52.33)*		
All hybrid	<55	13,015	0.89 (0.74-1.07)	1.52 (1.32-1.76)	2.10 (1.84-2.40)	4.28 (3.79-4.84)	8.06 (6.98-9.30)	*10.55 (8.39-13.24)*	16,694	0.73 (0.61-0.88)	1.37 (1.19-1.56)	1.92 (1.70-2.17)	3.74 (3.35-4.18)	5.94 (5.22-6.77)	*6.91 (5.90-8.09)*
MoP	<55	1,965	1.51 (1.05-2.16)	2.44 (1.83-3.26)	3.28 (2.53-4.26)	5.60 (4.40-7.12)	*9.28 (6.97-12.30)*	*12.82 (8.62-18.84)*	2,767	0.81 (0.54-1.24)	1.85 (1.39-2.46)	2.40 (1.86-3.10)	4.19 (3.34-5.26)	*8.39 (6.49-10.83)*	*9.39 (7.15-12.28)*
MoM	<55	300	0.00 (.-.)	2.36 (1.13-4.89)	4.46 (2.62-7.57)	*16.06 (12.25-20.92)*	*25.04 (20.09-30.96)*		221	*1.82 (0.69-4.77)*	*3.66 (1.85-7.18)*	*8.45 (5.41-13.09)*	*21.03 (16.04-27.31)*	*23.96 (18.37-30.90)*	

Note: All cases includes unconfirmed hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.H6 (continued)

Fixation and bearing surface	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
CoP	<55	7,215	0.90 (0.70-1.15)	1.38 (1.12-1.70)	1.76 (1.43-2.16)	2.78 (2.18-3.53)	*5.59 (3.43-9.03)*	*10.37 (4.95-21.02)*	8,709	0.75 (0.59-0.96)	1.26 (1.03-1.54)	1.54 (1.27-1.86)	2.90 (2.30-3.65)	*3.80 (2.75-5.23)*	*5.58 (3.42-9.05)*
CoC	<55	3,312	0.58 (0.37-0.90)	1.14 (0.83-1.57)	1.72 (1.32-2.24)	3.13 (2.52-3.88)	5.54 (4.36-7.04)	*7.36 (4.39-12.19)*	4,741	0.55 (0.38-0.81)	1.05 (0.80-1.39)	1.66 (1.32-2.08)	3.03 (2.52-3.64)	4.60 (3.80-5.57)	*5.60 (4.23-7.38)*
MoPoM	<55	110	*1.83 (0.46-7.11)*	*3.07 (0.99-9.34)*	*3.07 (0.99-9.34)*				162	*1.99 (0.65-6.07)*	*2.93 (1.09-7.72)*	*2.93 (1.09-7.72)*			
CoPoM	<55	99	*1.02 (0.14-7.02)*	*1.02 (0.14-7.02)*	*1.02 (0.14-7.02)*				85	*0.00 (.-.)*	*3.85 (0.55-24.31)*				
All reverse hybrid	**<55**	**971**	**1.15 (0.64-2.07)**	**2.30 (1.50-3.50)**	**2.87 (1.94-4.22)**	*5.60 (3.85-8.10)*	*10.85 (7.03-16.55)*		**1,385**	**1.12 (0.67-1.84)**	**1.85 (1.24-2.75)**	**2.84 (2.03-3.97)**	**4.59 (3.37-6.23)**	*8.64 (5.65-13.08)*	
MoP	<55	186	*0.56 (0.08-3.94)*	*4.15 (2.00-8.52)*	*4.15 (2.00-8.52)*	*8.14 (4.21-15.46)*	*17.60 (9.04-32.67)*		286	0.36 (0.05-2.56)	*0.78 (0.20-3.10)*	*1.78 (0.67-4.72)*	*3.20 (1.41-7.20)*	*7.51 (3.17-17.22)*	
CoP	<55	771	1.31 (0.71-2.43)	1.88 (1.12-3.16)	2.60 (1.64-4.12)	*4.98 (3.17-7.78)*	*8.78 (5.00-15.19)*		1,063	1.26 (0.73-2.16)	2.00 (1.30-3.09)	2.64 (1.78-3.89)	*3.62 (2.44-5.34)*	*8.14 (4.37-14.89)*	
Others	<55	14	*0.00 (.-.)*	*0.00 (.-.)*					36	*2.78 (0.40-18.13)*	*5.72 (1.46-21.02)*	*16.50 (7.15-35.49)*	*38.62 (22.56-60.61)*		
All resurfacing	**<55**	**14,731**	**0.82 (0.69-0.98)**	**2.13 (1.90-2.38)**	**3.76 (3.46-4.10)**	**7.17 (6.74-7.63)**	**9.80 (9.24-10.40)**	**10.47 (9.80-11.18)**	**5,704**	**1.23 (0.97-1.55)**	**4.93 (4.40-5.53)**	**9.11 (8.39-9.89)**	**19.46 (18.44-20.52)**	**24.41 (23.26-25.60)**	*26.06 (24.66-27.52)*
MoM	<55	14,633	0.82 (0.69-0.98)	2.12 (1.90-2.37)	3.76 (3.45-4.09)	7.17 (6.73-7.63)	9.80 (9.24-10.40)	10.46 (9.79-11.17)	5,646	1.22 (0.97-1.55)	4.95 (4.41-5.55)	9.14 (8.41-9.92)	19.48 (18.46-20.55)	24.43 (23.28-25.63)	*26.08 (24.68-27.54)*
Others	<55	98	*1.54 (0.22-10.42)*	*4.00 (0.98-15.62)*					58	*2.08 (0.30-13.88)*	*2.08 (0.30-13.88)*				
All cases	**55 to 64**	**132,734**	**0.89 (0.84-0.94)**	**1.74 (1.67-1.81)**	**2.53 (2.44-2.62)**	**4.99 (4.84-5.14)**	**7.92 (7.66-8.19)**	**9.46 (8.99-9.94)**	**160,646**	**0.71 (0.66-0.75)**	**1.48 (1.42-1.54)**	**2.30 (2.22-2.38)**	**4.84 (4.71-4.98)**	**7.78 (7.55-8.02)**	**9.25 (8.84-9.67)**
All cemented	**55 to 64**	**18,570**	**0.70 (0.59-0.83)**	**1.46 (1.29-1.65)**	**1.98 (1.78-2.20)**	**3.93 (3.59-4.29)**	**7.44 (6.80-8.13)**	**9.24 (8.22-10.37)**	**31,205**	**0.47 (0.40-0.56)**	**1.03 (0.92-1.15)**	**1.59 (1.44-1.74)**	**3.31 (3.07-3.57)**	**6.46 (6.01-6.95)**	**8.27 (7.48-9.13)**
MoP	55 to 64	11,456	0.72 (0.58-0.89)	1.70 (1.48-1.96)	2.29 (2.02-2.59)	4.62 (4.18-5.10)	8.42 (7.66-9.25)	10.28 (9.12-11.57)	20,398	0.52 (0.43-0.63)	1.20 (1.06-1.36)	1.84 (1.65-2.04)	3.74 (3.45-4.07)	7.06 (6.54-7.63)	8.95 (8.07-9.91)
MoM	55 to 64	26	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*			54	*1.89 (0.27-12.65)*	*1.89 (0.27-12.65)*	*1.89 (0.27-12.65)*	*8.24 (3.17-20.53)*	*12.67 (5.89-26.12)*	
CoP	55 to 64	6,980	0.68 (0.51-0.91)	1.04 (0.82-1.31)	1.42 (1.15-1.75)	2.32 (1.90-2.83)	4.74 (3.62-6.21)	*5.66 (4.23-7.55)*	10,565	0.37 (0.27-0.51)	0.68 (0.54-0.87)	1.04 (0.85-1.28)	2.12 (1.76-2.55)	4.39 (3.53-5.45)	*5.46 (4.27-6.98)*
MoPoM	55 to 64	97	*0.00 (.-.)*	*1.39 (0.20-9.45)*	*3.79 (0.91-15.04)*				165	*0.75 (0.11-5.18)*	*0.75 (0.11-5.18)*	*1.84 (0.45-7.32)*			
CoPoM	55 to 64	10							23	*0.00 (.-.)*	*0.00 (.-.)*				

Note: All cases includes unconfirmed hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.H6 (continued)

Fixation and bearing surface	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
All uncemented	**55 to 64**	**69,465**	**0.87 (0.80-0.94)**	**1.75 (1.65-1.85)**	**2.56 (2.43-2.69)**	**5.26 (5.04-5.49)**	**8.26 (7.85-8.69)**	***10.15 (9.11-11.30)***	**77,956**	**0.76 (0.70-0.83)**	**1.59 (1.50-1.68)**	**2.43 (2.31-2.55)**	**5.03 (4.84-5.24)**	**7.74 (7.39-8.10)**	**8.80 (8.23-9.41)**
MoP	55 to 64	16,872	0.94 (0.80-1.10)	1.80 (1.60-2.02)	2.31 (2.08-2.57)	4.16 (3.77-4.59)	7.52 (6.64-8.52)	*11.91 (8.97-15.74)*	20,964	0.71 (0.61-0.84)	1.49 (1.33-1.68)	1.86 (1.68-2.07)	3.47 (3.17-3.80)	6.03 (5.42-6.70)	*8.15 (6.76-9.81)*
MoM	55 to 64	5,212	0.85 (0.63-1.14)	3.04 (2.61-3.55)	6.62 (5.97-7.34)	16.47 (15.47-17.54)	21.19 (19.99-22.44)	*22.26 (20.85-23.75)*	4,885	0.92 (0.69-1.23)	3.84 (3.33-4.42)	9.37 (8.58-10.23)	22.49 (21.32-23.71)	27.72 (26.39-29.10)	*28.79 (27.19-30.46)*
CoP	55 to 64	22,466	0.79 (0.68-0.92)	1.34 (1.19-1.51)	1.72 (1.54-1.93)	2.79 (2.46-3.15)	4.61 (3.88-5.47)	*5.35 (4.38-6.53)*	24,967	0.63 (0.54-0.74)	1.17 (1.03-1.32)	1.56 (1.40-1.75)	2.73 (2.43-3.07)	3.97 (3.41-4.61)	*4.21 (3.58-4.95)*
CoC	55 to 64	24,376	0.91 (0.79-1.03)	1.72 (1.56-1.90)	2.24 (2.06-2.44)	3.51 (3.25-3.79)	5.01 (4.48-5.61)	*5.58 (4.84-6.43)*	26,463	0.89 (0.78-1.01)	1.54 (1.40-1.70)	1.99 (1.82-2.17)	2.92 (2.70-3.15)	4.38 (3.93-4.87)	*4.98 (4.31-5.75)*
CoM	55 to 64	317	0.63 (0.16-2.50)	2.87 (1.50-5.44)	5.17 (3.20-8.30)	*7.68 (5.17-11.35)*			467	0.43 (0.11-1.70)	1.95 (1.02-3.72)	3.28 (1.99-5.37)	6.84 (4.86-9.58)		
MoPoM	55 to 64	79	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*				108	*2.00 (0.50-7.80)*	*4.09 (1.23-13.11)*	*4.09 (1.23-13.11)*			
CoPoM	55 to 64	125	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*				85	*1.33 (0.19-9.09)*	*4.00 (0.94-16.19)*				
Others	55 to 64	18	*5.56 (0.80-33.36)*	*5.56 (0.80-33.36)*	*5.56 (0.80-33.36)*				17			*6.25 (0.90-36.77)*			
All hybrid	**55 to 64**	**25,905**	**0.86 (0.76-0.98)**	**1.50 (1.35-1.66)**	**2.03 (1.85-2.23)**	**3.58 (3.26-3.92)**	**6.01 (5.40-6.69)**	***8.17 (6.76-9.84)***	**38,019**	**0.60 (0.52-0.68)**	**1.15 (1.04-1.27)**	**1.62 (1.49-1.77)**	**3.22 (2.97-3.48)**	**4.96 (4.55-5.41)**	***5.73 (5.10-6.44)***
MoP	55 to 64	7,360	1.00 (0.79-1.26)	1.75 (1.47-2.09)	2.33 (1.99-2.74)	3.84 (3.31-4.45)	6.08 (5.16-7.16)	*8.13 (6.29-10.46)*	12,189	0.75 (0.61-0.92)	1.26 (1.07-1.48)	1.78 (1.55-2.06)	3.46 (3.07-3.90)	5.66 (5.00-6.41)	*6.26 (5.44-7.20)*
MoM	55 to 64	380	0.79 (0.26-2.43)	4.31 (2.66-6.94)	7.38 (5.12-10.58)	16.24 (12.76-20.54)	*22.87 (18.49-28.09)*		415	0.73 (0.23-2.23)	3.47 (2.07-5.78)	8.15 (5.83-11.33)	22.14 (18.25-26.71)	*27.83 (23.47-32.81)*	*29.27 (24.29-35.02)*
CoP	55 to 64	13,418	0.83 (0.69-1.00)	1.33 (1.13-1.55)	1.65 (1.42-1.92)	2.73 (2.22-3.36)	*5.42 (3.85-7.61)*	*5.42 (3.85-7.61)*	18,548	0.54 (0.45-0.66)	1.06 (0.91-1.23)	1.34 (1.16-1.56)	2.16 (1.80-2.59)	3.70 (2.77-4.94)	*4.66 (3.23-6.70)*
CoC	55 to 64	4,410	0.66 (0.46-0.95)	1.15 (0.87-1.52)	1.69 (1.34-2.13)	2.76 (2.27-3.36)	4.39 (3.59-5.37)	*7.06 (4.09-12.04)*	6,419	0.42 (0.29-0.62)	1.00 (0.79-1.28)	1.41 (1.15-1.74)	2.45 (2.07-2.91)	3.13 (2.63-3.72)	*4.01 (2.75-5.83)*
MoPoM	55 to 64	169	*2.58 (0.97-6.73)*	*2.58 (0.97-6.73)*	*2.58 (0.97-6.73)*				286	*1.07 (0.35-3.30)*	*1.87 (0.65-5.31)*	*1.87 (0.65-5.31)*			
CoPoM	55 to 64	149	*1.36 (0.34-5.33)*	*2.64 (0.81-8.43)*	*5.35 (1.71-16.08)*				144	*0.74 (0.10-5.14)*	*0.74 (0.10-5.14)*	*0.74 (0.10-5.14)*			
Others	55 to 64	19	*0.00 (.-.)*	*5.56 (0.80-33.36)*	*5.56 (0.80-33.36)*				18	*5.56 (0.80-33.36)*	*5.56 (0.80-33.36)*	*5.56 (0.80-33.36)*	*5.56 (0.80-33.36)*		

Note: All cases includes unconfirmed hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.H6 (continued)

Fixation and bearing surface	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
All reverse hybrid	**55 to 64**	**2,787**	**0.93 (0.63-1.37)**	**1.75 (1.31-2.34)**	**2.38 (1.84-3.09)**	**3.96 (3.05-5.14)**	*8.18 (5.39-12.31)*		**4,346**	**0.90 (0.65-1.23)**	**1.62 (1.28-2.06)**	**2.22 (1.80-2.75)**	**3.72 (3.03-4.55)**	*7.63 (5.53-10.48)*	*8.83 (6.02-12.86)*
MoP	55 to 64	1,074	0.77 (0.38-1.53)	1.29 (0.75-2.21)	2.27 (1.46-3.53)	*4.17 (2.68-6.45)*	*9.10 (5.57-14.69)*		1,812	1.18 (0.77-1.80)	1.85 (1.31-2.61)	2.62 (1.94-3.54)	4.71 (3.54-6.24)	*10.52 (7.10-15.44)*	
CoP	55 to 64	1,703	1.03 (0.64-1.66)	2.06 (1.46-2.90)	2.48 (1.80-3.42)	3.86 (2.80-5.31)	*8.51 (3.96-17.79)*		2,507	0.70 (0.44-1.13)	1.48 (1.06-2.06)	1.91 (1.41-2.58)	2.85 (2.13-3.81)	*3.88 (2.76-5.45)*	
Others	55 to 64	10							27	*0.00 (.-.)*	*0.00 (.-.)*	*4.76 (0.68-29.28)*	*12.09 (3.05-41.52)*		
All resurfacing	**55 to 64**	**12,339**	**1.18 (1.01-1.39)**	**2.33 (2.07-2.61)**	**3.70 (3.38-4.06)**	**6.84 (6.39-7.33)**	**9.39 (8.81-10.01)**	**10.11 (9.45-10.82)**	**4,414**	**1.61 (1.28-2.03)**	**4.38 (3.81-5.03)**	**8.34 (7.55-9.20)**	**17.00 (15.91-18.17)**	**21.89 (20.63-23.21)**	*24.14 (22.52-25.85)*
MoM	55 to 64	12,275	1.18 (1.00-1.39)	2.32 (2.06-2.60)	3.70 (3.37-4.05)	6.84 (6.38-7.32)	9.39 (8.81-10.00)	10.10 (9.44-10.81)	4,370	1.63 (1.29-2.05)	4.41 (3.84-5.06)	8.37 (7.59-9.24)	17.04 (15.94-18.20)	21.92 (20.66-23.24)	*24.17 (22.55-25.89)*
Others	55 to 64	64	*2.00 (0.28-13.36)*	*4.97 (1.23-18.94)*					44	*0.00 (.-.)*	*0.00 (.-.)*				
All cases	**65 to 74**	**185,031**	**0.88 (0.84-0.92)**	**1.50 (1.44-1.56)**	**2.04 (1.97-2.11)**	**3.85 (3.73-3.97)**	**6.33 (6.10-6.56)**	**7.58 (7.14-8.05)**	**286,679**	**0.70 (0.67-0.73)**	**1.25 (1.21-1.29)**	**1.75 (1.70-1.80)**	**3.27 (3.19-3.36)**	**5.14 (4.99-5.31)**	*6.07 (5.78-6.37)*
All cemented	**65 to 74**	**52,928**	**0.67 (0.60-0.74)**	**1.25 (1.16-1.35)**	**1.73 (1.62-1.85)**	**3.52 (3.32-3.72)**	**6.15 (5.78-6.53)**	**7.55 (6.91-8.24)**	**99,884**	**0.48 (0.44-0.53)**	**1.02 (0.96-1.09)**	**1.45 (1.37-1.53)**	**2.70 (2.58-2.83)**	**4.61 (4.39-4.85)**	**5.47 (5.11-5.85)**
MoP	65 to 74	45,467	0.69 (0.62-0.77)	1.29 (1.19-1.40)	1.79 (1.67-1.93)	3.67 (3.46-3.90)	6.34 (5.95-6.74)	7.69 (7.04-8.41)	86,613	0.47 (0.43-0.52)	1.03 (0.96-1.10)	1.47 (1.39-1.56)	2.78 (2.65-2.92)	4.71 (4.47-4.96)	5.58 (5.21-5.98)
MoM	65 to 74	59	*1.69 (0.24-11.43)*	*3.45 (0.87-13.10)*	*3.45 (0.87-13.10)*	*5.86 (1.89-17.38)*	*11.40 (3.81-31.44)*		105	*0.95 (0.13-6.57)*	*0.95 (0.13-6.57)*	*2.98 (0.97-8.97)*	*6.18 (2.82-13.26)*	*8.79 (4.47-16.91)*	
CoP	65 to 74	7,179	0.52 (0.37-0.72)	0.90 (0.70-1.16)	1.25 (0.99-1.56)	2.11 (1.71-2.60)	4.35 (3.30-5.72)	*6.61 (3.97-10.90)*	12,682	0.51 (0.40-0.65)	0.97 (0.81-1.17)	1.19 (1.00-1.42)	1.83 (1.54-2.19)	3.56 (2.87-4.40)	*4.08 (3.15-5.27)*
MoPoM	65 to 74	195	*1.58 (0.51-4.83)*	*2.94 (1.22-6.98)*	*2.94 (1.22-6.98)*				441	0.95 (0.36-2.52)	0.95 (0.36-2.52)	*1.93 (0.82-4.50)*	*1.93 (0.82-4.50)*		
CoPoM	65 to 74	26	*0.00 (.-.)*	*4.76 (0.68-29.28)*					42	*2.63 (0.37-17.25)*	*2.63 (0.37-17.25)*				
All uncemented	**65 to 74**	**75,353**	**0.94 (0.87-1.01)**	**1.61 (1.52-1.70)**	**2.19 (2.08-2.31)**	**4.12 (3.93-4.31)**	**6.88 (6.46-7.32)**	*7.93 (7.21-8.72)*	**95,707**	**0.88 (0.82-0.94)**	**1.51 (1.43-1.59)**	**2.16 (2.07-2.27)**	**4.11 (3.95-4.28)**	**6.24 (5.93-6.56)**	*7.79 (6.82-8.89)*
MoP	65 to 74	33,334	0.91 (0.81-1.02)	1.54 (1.41-1.68)	1.91 (1.76-2.08)	3.49 (3.23-3.77)	6.26 (5.59-7.00)	*6.66 (5.87-7.56)*	46,543	0.91 (0.83-1.00)	1.42 (1.32-1.54)	1.83 (1.70-1.96)	3.13 (2.93-3.34)	5.14 (4.70-5.62)	*5.70 (5.11-6.36)*
MoM	65 to 74	4,594	1.07 (0.81-1.41)	2.95 (2.50-3.49)	6.09 (5.42-6.83)	13.61 (12.60-14.70)	17.95 (16.63-19.36)		4,674	1.12 (0.85-1.46)	3.55 (3.06-4.13)	8.61 (7.83-9.46)	19.13 (17.99-20.34)	23.09 (21.75-24.49)	
CoP	65 to 74	21,114	0.82 (0.71-0.96)	1.23 (1.08-1.40)	1.47 (1.30-1.66)	2.15 (1.89-2.46)	3.63 (2.93-4.48)	*3.98 (3.17-4.99)*	25,208	0.71 (0.61-0.82)	1.17 (1.04-1.32)	1.47 (1.32-1.65)	2.39 (2.13-2.69)	3.60 (3.10-4.18)	*4.62 (3.67-5.79)*

Note: All cases includes unconfirmed hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.H6 (continued)

Fixation and bearing surface	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
CoC	65 to 74	15,824	1.10 (0.95-1.28)	1.74 (1.54-1.96)	2.18 (1.96-2.43)	2.94 (2.66-3.25)	4.63 (3.96-5.41)	*6.99 (4.92-9.89)*	18,618	0.92 (0.80-1.07)	1.53 (1.36-1.72)	1.82 (1.63-2.02)	2.45 (2.21-2.70)	3.64 (3.13-4.24)	*8.48 (4.18-16.78)*
CoM	65 to 74	304	1.32 (0.50-3.49)	3.71 (2.07-6.60)	5.13 (3.12-8.37)	*8.54 (5.80-12.49)*			379	0.53 (0.13-2.11)	1.60 (0.72-3.53)	3.50 (2.05-5.96)	7.64 (5.30-10.95)		
MoPoM	65 to 74	97	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*				183	*4.52 (2.28-8.84)*	*6.01 (3.26-10.95)*	*6.01 (3.26-10.95)*	*6.01 (3.26-10.95)*		
CoPoM	65 to 74	77	*0.00 (.-.)*	*4.76 (0.68-29.28)*					78	*0.00 (.-.)*	*0.00 (.-.)*				
Others	65 to 74	9							24	*8.33 (2.15-29.39)*	*12.50 (4.21-33.92)*	*12.50 (4.21-33.92)*			
All hybrid	**65 to 74**	**43,570**	**0.90 (0.82-1.00)**	**1.44 (1.32-1.56)**	**1.88 (1.74-2.03)**	**3.37 (3.11-3.64)**	**5.22 (4.74-5.75)**	*6.78 (5.42-8.45)*	**74,076**	**0.75 (0.69-0.81)**	**1.18 (1.10-1.26)**	**1.57 (1.48-1.68)**	**2.69 (2.52-2.87)**	**3.91 (3.61-4.24)**	*4.36 (3.91-4.85)*
MoP	65 to 74	23,732	0.94 (0.83-1.08)	1.51 (1.36-1.68)	1.99 (1.81-2.20)	3.56 (3.24-3.91)	5.46 (4.88-6.11)	*6.41 (5.10-8.05)*	43,473	0.77 (0.69-0.85)	1.23 (1.13-1.35)	1.65 (1.52-1.79)	2.79 (2.59-3.02)	3.98 (3.63-4.36)	*4.38 (3.89-4.93)*
MoM	65 to 74	322	1.24 (0.47-3.28)	2.22 (1.07-4.61)	3.98 (2.27-6.90)	*13.02 (9.51-17.71)*	*18.11 (13.48-24.11)*		396	0.76 (0.25-2.33)	1.79 (0.86-3.73)	5.67 (3.73-8.57)	*12.85 (9.70-16.91)*	*16.63 (12.75-21.54)*	
CoP	65 to 74	16,007	0.82 (0.69-0.98)	1.24 (1.07-1.44)	1.51 (1.30-1.75)	2.21 (1.81-2.70)	*2.81 (1.92-4.11)*	*7.30 (2.96-17.40)*	25,174	0.69 (0.59-0.80)	1.07 (0.94-1.22)	1.32 (1.16-1.49)	1.87 (1.62-2.15)	3.31 (2.43-4.51)	*4.52 (2.93-6.95)*
CoC	65 to 74	2,915	0.73 (0.47-1.11)	1.41 (1.04-1.92)	1.93 (1.48-2.53)	2.81 (2.20-3.57)	*4.27 (3.31-5.48)*		3,933	0.72 (0.50-1.04)	0.93 (0.67-1.29)	1.31 (0.99-1.73)	2.16 (1.70-2.74)	2.79 (2.16-3.60)	
MoPoM	65 to 74	418	2.40 (1.25-4.57)	*3.27 (1.78-5.96)*	*3.27 (1.78-5.96)*				832	1.66 (0.96-2.84)	2.28 (1.39-3.75)	*2.86 (1.63-4.97)*			
CoPoM	65 to 74	156	*2.19 (0.71-6.69)*	*3.46 (1.26-9.32)*	*3.46 (1.26-9.32)*				238	*0.42 (0.06-2.96)*	*0.42 (0.06-2.96)*	*0.42 (0.06-2.96)*			
Others	65 to 74	20		*0.00 (.-.)*	*0.00 (.-.)*				30		*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*		
All reverse hybrid	**65 to 74**	**5,164**	**1.01 (0.77-1.33)**	**1.67 (1.34-2.08)**	**2.05 (1.67-2.51)**	**3.37 (2.75-4.12)**	*6.28 (4.53-8.67)*		**8,704**	**0.52 (0.38-0.69)**	**0.98 (0.79-1.22)**	**1.42 (1.17-1.71)**	**2.61 (2.18-3.13)**	*3.34 (2.72-4.09)*	
MoP	65 to 74	3,629	1.22 (0.90-1.64)	1.86 (1.46-2.38)	2.33 (1.86-2.93)	3.93 (3.12-4.94)	*7.88 (5.46-11.30)*		6,431	0.54 (0.39-0.75)	1.01 (0.78-1.29)	1.39 (1.11-1.73)	2.78 (2.26-3.41)	*3.29 (2.63-4.10)*	
CoP	65 to 74	1,521	0.54 (0.27-1.07)	1.23 (0.76-1.97)	1.40 (0.89-2.19)	2.09 (1.38-3.18)	*2.76 (1.56-4.87)*		2,242	0.36 (0.18-0.73)	0.82 (0.51-1.32)	1.37 (0.93-2.02)	2.06 (1.40-3.05)	*3.32 (2.07-5.30)*	
Others	65 to 74	14	*0.00 (.-.)*	*0.00 (.-.)*					31	*6.68 (1.71-24.20)*	*6.68 (1.71-24.20)*	*10.74 (3.56-29.92)*			

Note: All cases includes unconfirmed hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.H6 (continued)

Fixation and bearing surface	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
All resurfacing	**65 to 74**	**3,212**	**1.94 (1.52-2.49)**	**2.92 (2.38-3.57)**	**4.22 (3.57-5.00)**	**7.09 (6.21-8.10)**	**8.67 (7.63-9.84)**	***9.63 (8.09-11.46)***	**772**	**1.56 (0.89-2.73)**	**3.14 (2.11-4.65)**	**5.82 (4.36-7.74)**	**13.70 (11.40-16.42)**	***18.90 (16.02-22.23)***	***21.12 (17.46-25.43)***
MoM	65 to 74	3,197	1.95 (1.53-2.50)	2.93 (2.39-3.58)	4.23 (3.58-5.01)	7.10 (6.22-8.11)	8.68 (7.64-9.86)	*9.65 (8.10-11.47)*	748	1.47 (0.82-2.64)	3.08 (2.06-4.61)	5.79 (4.33-7.73)	13.70 (11.39-16.43)	*18.93 (16.03-22.28)*	*21.14 (17.47-25.46)*
Others	65 to 74	15							24	*4.17 (0.60-26.08)*	*4.17 (0.60-26.08)*				
All cases	**≥75**	**142,122**	**1.00 (0.95-1.05)**	**1.54 (1.48-1.61)**	**2.00 (1.92-2.09)**	**3.35 (3.21-3.50)**	**5.08 (4.74-5.45)**	***5.69 (5.02-6.46)***	**276,308**	**0.73 (0.69-0.76)**	**1.12 (1.08-1.16)**	**1.45 (1.41-1.50)**	**2.39 (2.31-2.47)**	**3.40 (3.24-3.58)**	**4.24 (3.67-4.89)**
All cemented	**≥75**	**60,647**	**0.83 (0.76-0.91)**	**1.35 (1.26-1.45)**	**1.81 (1.69-1.93)**	**3.08 (2.88-3.30)**	**4.56 (4.14-5.03)**	***5.19 (4.41-6.09)***	**135,206**	**0.47 (0.43-0.50)**	**0.84 (0.79-0.89)**	**1.14 (1.08-1.20)**	**1.95 (1.85-2.05)**	***2.78 (2.59-2.99)***	***3.33 (2.76-4.00)***
MoP	≥75	57,028	0.83 (0.76-0.91)	1.35 (1.25-1.45)	1.80 (1.68-1.92)	3.10 (2.89-3.32)	4.64 (4.20-5.12)	*5.28 (4.48-6.21)*	127,610	0.47 (0.43-0.51)	0.84 (0.79-0.90)	1.14 (1.08-1.20)	1.95 (1.85-2.06)	2.79 (2.59-3.00)	*3.36 (2.78-4.05)*
MoM	≥75	50		*0.00 (.-.)*	*2.33 (0.33-15.38)*	*9.86 (3.20-28.24)*			111	*0.00 (.-.)*	*3.12 (1.02-9.36)*	*3.12 (1.02-9.36)*	*6.00 (2.50-14.01)*	*8.13 (3.60-17.83)*	
CoP	≥75	3,079	0.75 (0.49-1.14)	1.27 (0.91-1.78)	1.60 (1.16-2.21)	2.10 (1.46-3.02)	*2.10 (1.46-3.02)*		6,247	0.37 (0.24-0.56)	0.64 (0.46-0.90)	0.83 (0.61-1.14)	1.41 (1.02-1.94)	*2.06 (1.35-3.13)*	
MoPoM	≥75	449	1.68 (0.80-3.49)	*2.90 (1.60-5.21)*	*4.63 (2.63-8.06)*				1,102	0.95 (0.51-1.75)	1.62 (0.99-2.63)	2.39 (1.51-3.77)			
CoPoM	≥75	39	*0.00 (.-.)*						135	*0.75 (0.11-5.22)*	*0.75 (0.11-5.22)*	*0.75 (0.11-5.22)*			
All uncemented	**≥75**	**36,803**	**1.28 (1.17-1.40)**	**1.84 (1.71-1.99)**	**2.27 (2.11-2.44)**	**3.74 (3.47-4.04)**	**5.65 (4.90-6.52)**		**54,219**	**1.22 (1.13-1.32)**	**1.67 (1.56-1.79)**	**2.09 (1.96-2.22)**	**3.47 (3.27-3.69)**	**5.38 (4.84-5.97)**	***7.13 (5.28-9.60)***
MoP	≥75	24,419	1.33 (1.20-1.49)	1.91 (1.74-2.09)	2.26 (2.06-2.46)	3.32 (3.01-3.65)	*5.33 (4.39-6.46)*		37,995	1.23 (1.12-1.34)	1.61 (1.49-1.75)	1.97 (1.83-2.12)	3.15 (2.92-3.40)	5.24 (4.48-6.12)	*7.43 (4.82-11.37)*
MoM	≥75	1,715	1.01 (0.63-1.62)	1.89 (1.33-2.68)	3.71 (2.87-4.79)	8.59 (7.14-10.31)	*10.88 (8.79-13.43)*		2,422	1.33 (0.94-1.87)	3.02 (2.40-3.79)	4.89 (4.07-5.86)	9.49 (8.26-10.89)	*12.00 (10.48-13.72)*	
CoP	≥75	6,739	1.04 (0.82-1.32)	1.47 (1.19-1.80)	1.81 (1.48-2.21)	2.86 (2.25-3.64)	*4.86 (2.70-8.67)*		8,758	1.03 (0.84-1.27)	1.40 (1.16-1.68)	1.70 (1.43-2.02)	2.61 (2.17-3.15)	*3.29 (2.56-4.22)*	
CoC	≥75	3,636	1.31 (0.98-1.74)	1.90 (1.50-2.41)	2.07 (1.65-2.61)	3.53 (2.84-4.37)	*4.10 (3.21-5.23)*		4,618	1.48 (1.17-1.88)	1.85 (1.50-2.29)	2.06 (1.68-2.52)	2.97 (2.43-3.62)	*4.80 (3.49-6.58)*	
CoM	≥75	88	*0.00 (.-.)*	*0.00 (.-.)*	*2.76 (0.70-10.59)*	*4.26 (1.39-12.63)*			133	*0.00 (.-.)*	*0.77 (0.11-5.33)*	*0.77 (0.11-5.33)*	*1.88 (0.46-7.50)*		
MoPoM	≥75	131	*5.46 (2.64-11.11)*	*5.46 (2.64-11.11)*	*5.46 (2.64-11.11)*	*5.46 (2.64-11.11)*			250	*2.61 (1.17-5.73)*	*3.35 (1.58-7.05)*	*3.35 (1.58-7.05)*	*3.35 (1.58-7.05)*		

Note: All cases includes unconfirmed hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.H6 (continued)

Fixation and bearing surface	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
CoPoM	≥75	64	*3.31 (0.84-12.60)*	*3.31 (0.84-12.60)*					38	*0.00 (.-.)*	*0.00 (.-.)*				
Others	≥75	11		*9.09 (1.33-49.19)*					5						
All hybrid	**≥75**	**36,367**	**0.96 (0.86-1.06)**	**1.48 (1.35-1.62)**	**1.94 (1.78-2.11)**	**3.30 (2.99-3.66)**	***4.71 (4.04-5.49)***		**70,615**	**0.76 (0.70-0.83)**	**1.12 (1.04-1.20)**	**1.47 (1.37-1.57)**	**2.13 (1.97-2.30)**	**2.72 (2.40-3.08)**	***3.54 (2.52-4.98)***
MoP	≥75	27,165	0.93 (0.82-1.06)	1.50 (1.35-1.66)	1.97 (1.79-2.17)	3.30 (2.95-3.69)	*4.86 (4.10-5.75)*		54,573	0.77 (0.70-0.85)	1.15 (1.06-1.25)	1.47 (1.36-1.59)	2.14 (1.97-2.33)	2.81 (2.46-3.21)	*3.73 (2.60-5.36)*
MoM	≥75	208	*0.97 (0.24-3.81)*	*1.50 (0.49-4.60)*	*2.07 (0.78-5.45)*	*10.26 (5.95-17.37)*	*10.26 (5.95-17.37)*		363	0.55 (0.14-2.20)	1.71 (0.77-3.78)	*4.28 (2.49-7.31)*	*9.08 (6.06-13.49)*	*9.08 (6.06-13.49)*	
CoP	≥75	7,450	1.07 (0.85-1.34)	1.46 (1.19-1.80)	1.86 (1.52-2.27)	*2.62 (2.05-3.35)*	*2.62 (2.05-3.35)*		12,540	0.73 (0.59-0.90)	0.97 (0.80-1.18)	1.39 (1.15-1.68)	1.59 (1.29-1.96)	*1.59 (1.29-1.96)*	
CoC	≥75	626	1.46 (0.76-2.80)	1.64 (0.89-3.03)	2.06 (1.17-3.62)	*2.89 (1.64-5.09)*			1,217	0.50 (0.22-1.10)	0.77 (0.40-1.47)	1.11 (0.63-1.96)	1.66 (0.97-2.84)	*1.66 (0.97-2.84)*	
MoPoM	≥75	712	0.49 (0.16-1.50)	0.89 (0.37-2.14)	*0.89 (0.37-2.14)*				1,596	0.72 (0.40-1.30)	0.96 (0.55-1.68)	1.31 (0.75-2.27)			
CoPoM	≥75	188	*0.00 (.-.)*	*0.00 (.-.)*					305	*1.14 (0.36-3.55)*	*1.14 (0.36-3.55)*	*1.14 (0.36-3.55)*			
Others	≥75	18		*0.00 (.-.)*					21	*4.76 (0.68-29.28)*	*4.76 (0.68-29.28)*				
All reverse hybrid	**≥75**	**3,996**	**1.11 (0.83-1.50)**	**1.87 (1.47-2.37)**	**2.49 (2.00-3.09)**	**3.75 (2.94-4.79)**	***4.55 (3.43-6.04)***		**7,444**	**0.81 (0.62-1.04)**	**1.23 (0.99-1.51)**	**1.51 (1.24-1.84)**	**2.71 (2.20-3.34)**	***3.98 (3.06-5.16)***	
MoP	≥75	3,567	1.16 (0.85-1.58)	1.93 (1.51-2.47)	2.50 (1.99-3.14)	3.91 (3.00-5.07)	*4.84 (3.56-6.55)*		6,617	0.80 (0.61-1.05)	1.23 (0.99-1.54)	1.49 (1.21-1.84)	2.77 (2.21-3.47)	*3.71 (2.77-4.94)*	
CoP	≥75	393	0.79 (0.26-2.44)	1.43 (0.60-3.42)	*2.14 (1.02-4.46)*	*2.59 (1.29-5.17)*			758	0.66 (0.28-1.59)	0.97 (0.46-2.02)	1.32 (0.69-2.53)	*2.09 (1.16-3.77)*		
Others	≥75	36	*0.00 (.-.)*	*0.00 (.-.)*					69	*3.18 (0.80-12.16)*	*3.18 (0.80-12.16)*	*8.03 (2.22-26.80)*			
All resurfacing	**≥75**	**224**	***1.80 (0.68-4.73)***	***2.81 (1.27-6.15)***	***4.45 (2.33-8.41)***	***6.98 (4.09-11.80)***	***6.98 (4.09-11.80)***		**32**	***3.13 (0.45-20.18)***	***6.58 (1.68-23.91)***	***6.58 (1.68-23.91)***	***11.77 (3.81-33.23)***		
MoM	≥75	223	*1.81 (0.68-4.75)*	*2.82 (1.27-6.17)*	*4.46 (2.34-8.42)*	*6.99 (4.10-11.82)*	*6.99 (4.10-11.82)*		29	*3.45 (0.49-22.05)*	*7.16 (1.84-25.75)*	*7.16 (1.84-25.75)*	*12.32 (4.04-34.21)*		

Note: All cases includes unconfirmed hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

3.2.3 Revisions after primary hip replacement: effect of head size for selected bearing surfaces / fixation sub-groups

This section looks at the effect of head size on the probability of revision following primary hip replacement. Fixation and bearing combinations with greater than 10,000 uses are included, and head sizes with fewer than 500 implantations within each group were excluded.

This gave us 12 groups:

a) Metal-on-polyethylene cemented hip constructs n=354,571

b) Ceramic-on-polyethylene cemented hip constructs n=54,658

c) Metal-on-polyethylene uncemented hip constructs n=191,950

d) Metal-on-metal uncemented hip constructs n=28,740

e) Ceramic-on-polyethylene uncemented hip constructs n=134,749

f) Ceramic-on-ceramic uncemented hip constructs n=137,355

g) Metal-on-polyethylene hybrid hip constructs n=173,032

h) Ceramic-on-polyethylene hybrid hip constructs n=108,865

i) Ceramic-on-ceramic hybrid hip constructs n=27,053

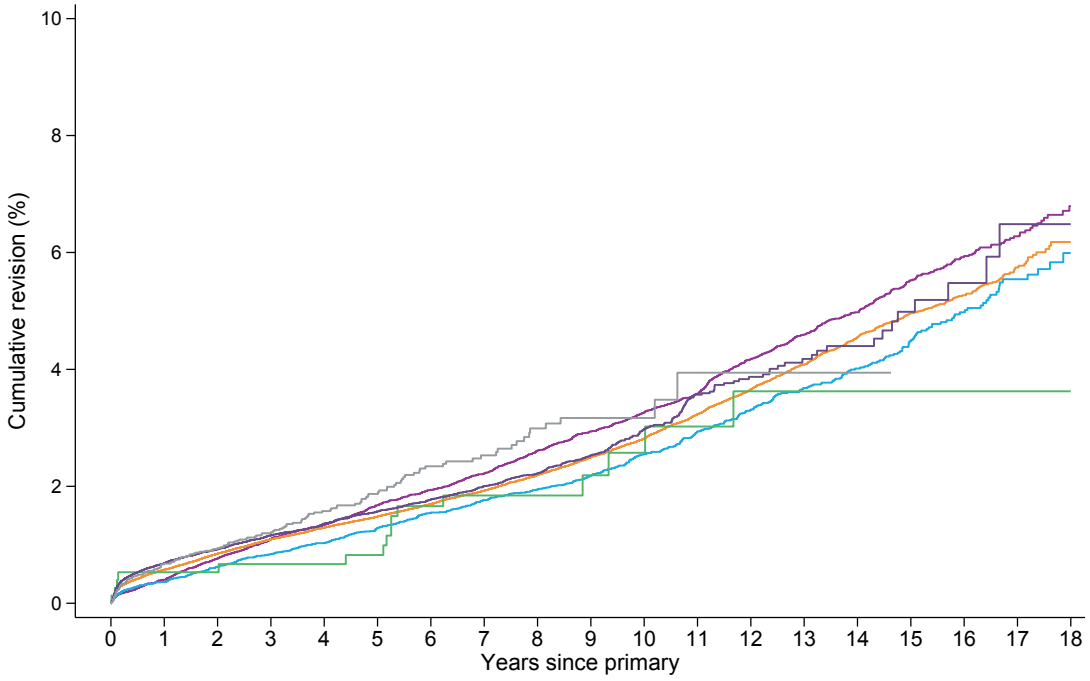
j) Metal-on-polyethylene reverse hybrid hip constructs n=22,862

k) Ceramic-on-polyethylene reverse hybrid hip constructs n=10,957

l) Metal-on-metal resurfacing n=40,497

Figures 3.H10 (a) to 3.H10 (l) (pages 78 to 89) show respective percentage cumulative probabilities of revision (Kaplan-Meier estimates) for various head sizes, for each of the groups with follow-up up to 18 years following the primary hip replacement.

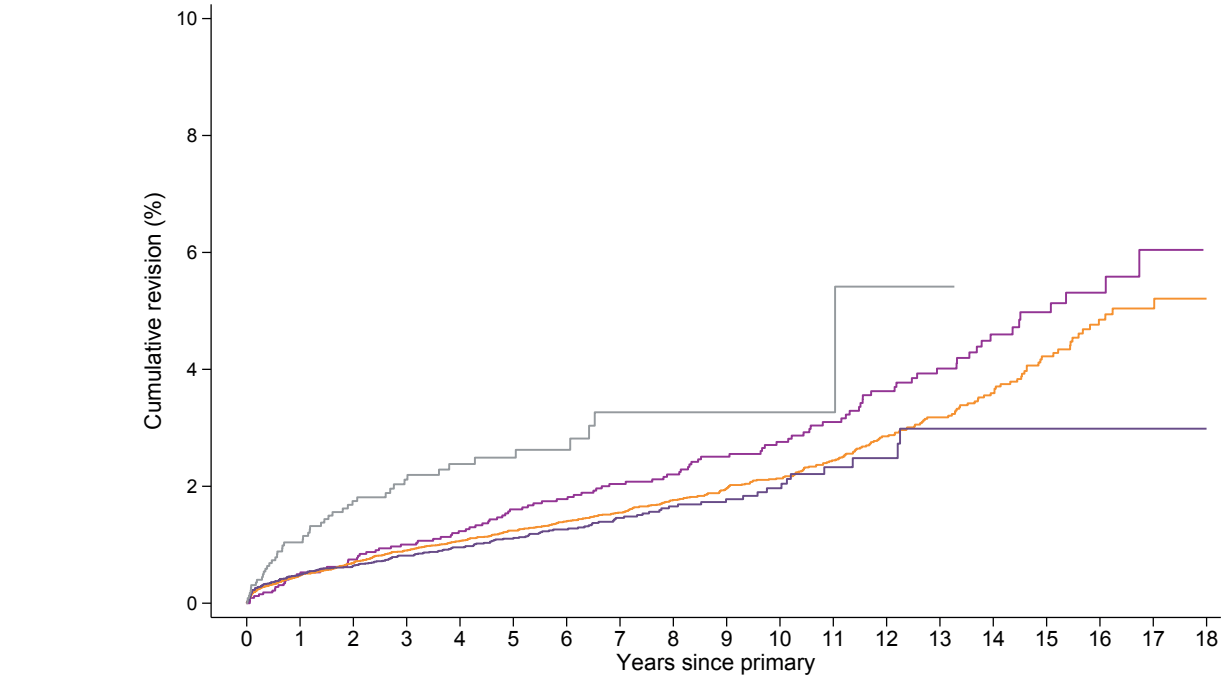
Figure 3.H10 (a) KM estimates of cumulative revision of primary cemented MoP hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
22.25	35,509	33,394	30,693	27,303	23,403	18,765	13,764	9,272	4,926	1,092
26	19,087	18,197	16,949	15,324	13,201	10,594	7,980	5,130	2,611	470
28	204,065	185,674	157,293	125,030	91,640	61,389	37,866	19,691	7,110	902
30	755	717	657	553	369	*217*	*146*	*63*	*20*	*<4*
32	86,717	69,664	46,901	28,467	14,538	6,227	2,453	898	273	*39*
36	8,438	6,328	4,158	2,493	1,229	376	*49*	*<4*		

In Figure 3.H10 (a), for cemented metal-on-polyethylene (MoP) hips, there was a statistically significant effect of head size (overall difference P<0.001 by logrank test) on revision rates over the follow-up period. Overall, implants with head size 22.25mm had the worst revision rates over the entire duration of follow-up, but implants with head size 36mm had the worst revision rates in the first nine years of follow-up. The numbers at risk for patients who received 36mm heads after 11 years are too small for meaningful comparison.

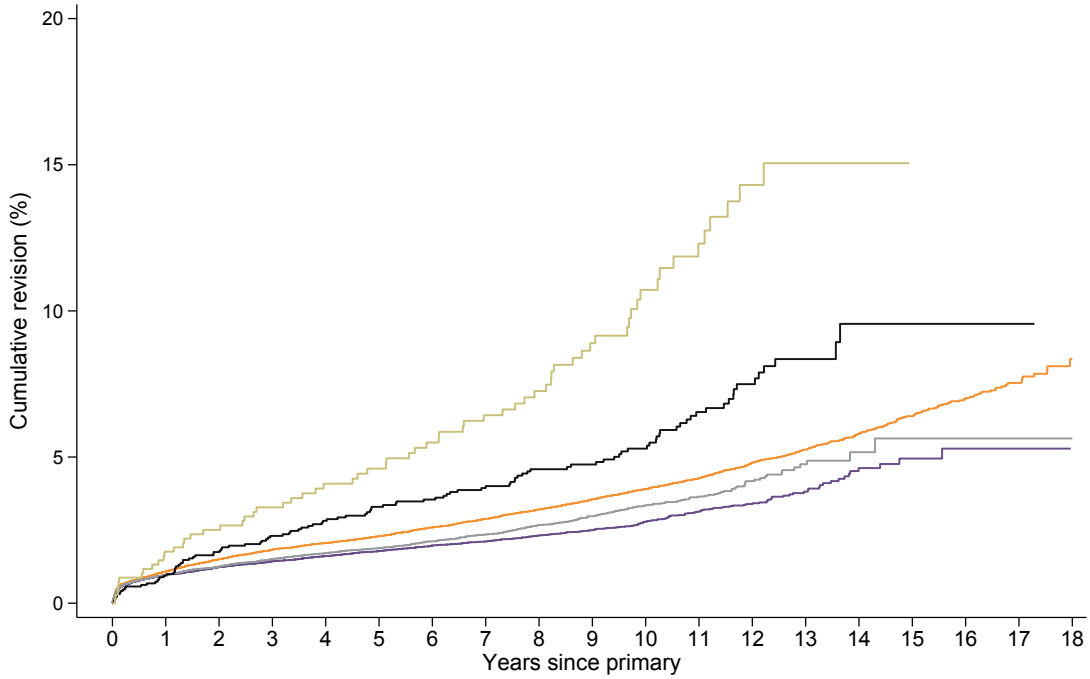
Figure 3.H10 (b) KM estimates of cumulative revision of primary cemented CoP hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
22.25	3,250	3,138	2,976	2,727	2,314	1,823	1,352	869	362	
28	31,063	27,250	21,877	16,617	11,927	7,797	4,702	2,528	1,097	*188*
32	18,064	14,107	9,539	5,850	2,958	1,286	444	*93*	*32*	*7*
36	2,281	1,534	975	516	266	*101*	*10*			

Figure 3.H10 (b) shows revision rates for different head sizes for cemented ceramic-on-polyethylene (CoP) hips. There was a statistically significant effect of head size (overall P<0.001) with 36mm heads having the highest revision rates, followed by 22.25mm heads. The lowest revision rates were achieved with 28mm and 32mm heads.

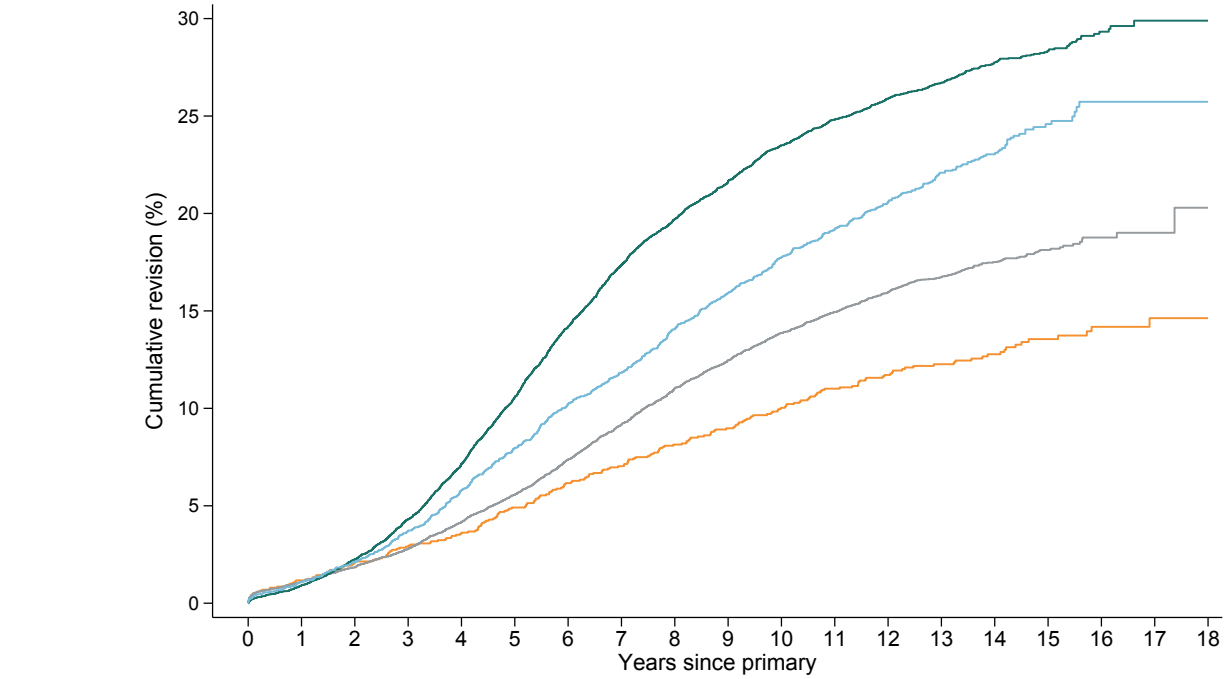
Figure 3.H10 (c) KM estimates of cumulative revision of primary uncemented MoP hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
28	59,296	55,145	49,238	42,036	33,521	24,746	16,036	8,309	3,106	340
32	88,043	75,547	56,206	37,126	21,178	9,846	3,581	923	*166*	
36	41,996	34,306	25,559	17,743	11,150	5,657	1,937	272	*31*	*<4*
40	1,929	1,806	1,670	1,506	1,266	926	477	*81*	*<4*	
44	686	646	576	518	424	263	*135*	*19*		

Figure 3.H10 (c) shows revision rates for uncemented metal-on-polyethylene (MoP) hips. Head sizes above 36mm had the highest revision rates.

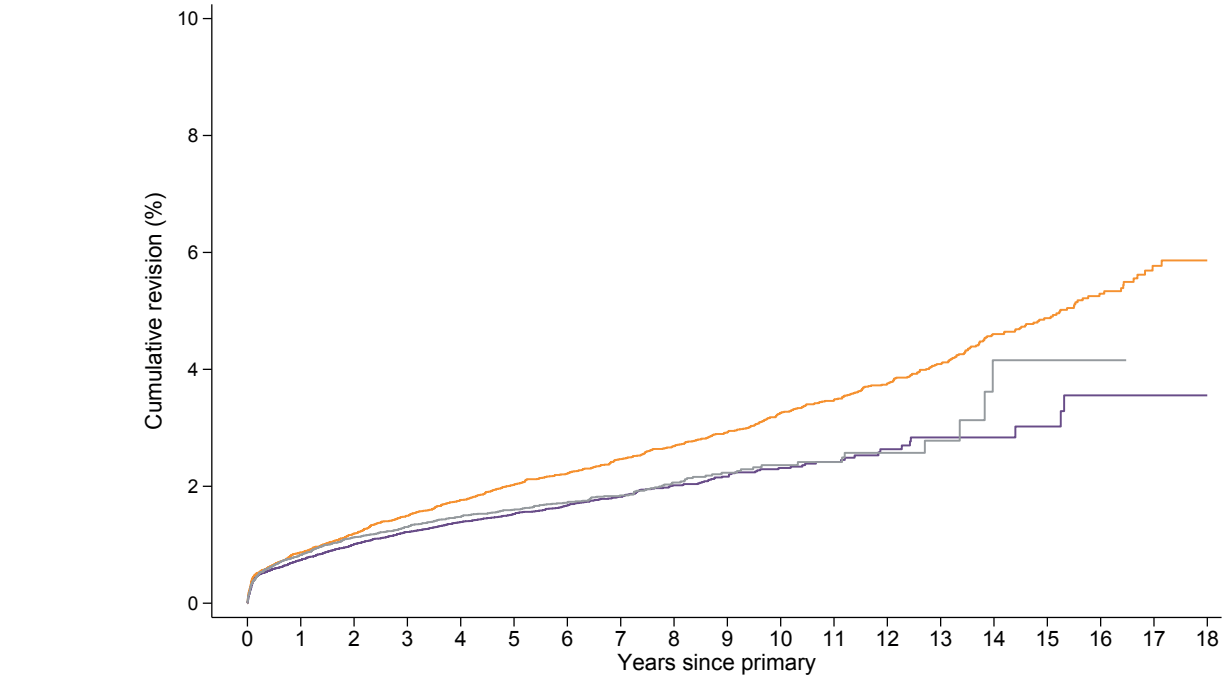
Figure 3.H10 (d) KM estimates of cumulative revision of primary uncemented MoM hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
28	1,878	1,812	1,738	1,634	1,556	1,419	1,182	758	340	*40*
36	12,353	11,791	11,110	10,221	9,224	8,238	6,571	2,756	490	*18*
38 to 48	10,784	10,396	9,641	8,645	7,775	7,035	5,919	2,848	599	*12*
50 to 54	3,725	3,584	3,359	3,097	2,862	2,595	2,114	988	*181*	*13*

Figure 3.H10 (d) shows revision rates for uncemented metal-on-metal (MoM) hips, with a statistically significant difference between the head sizes overall (P<0.001) with the lowest revision rates achieved with the smallest head sizes.

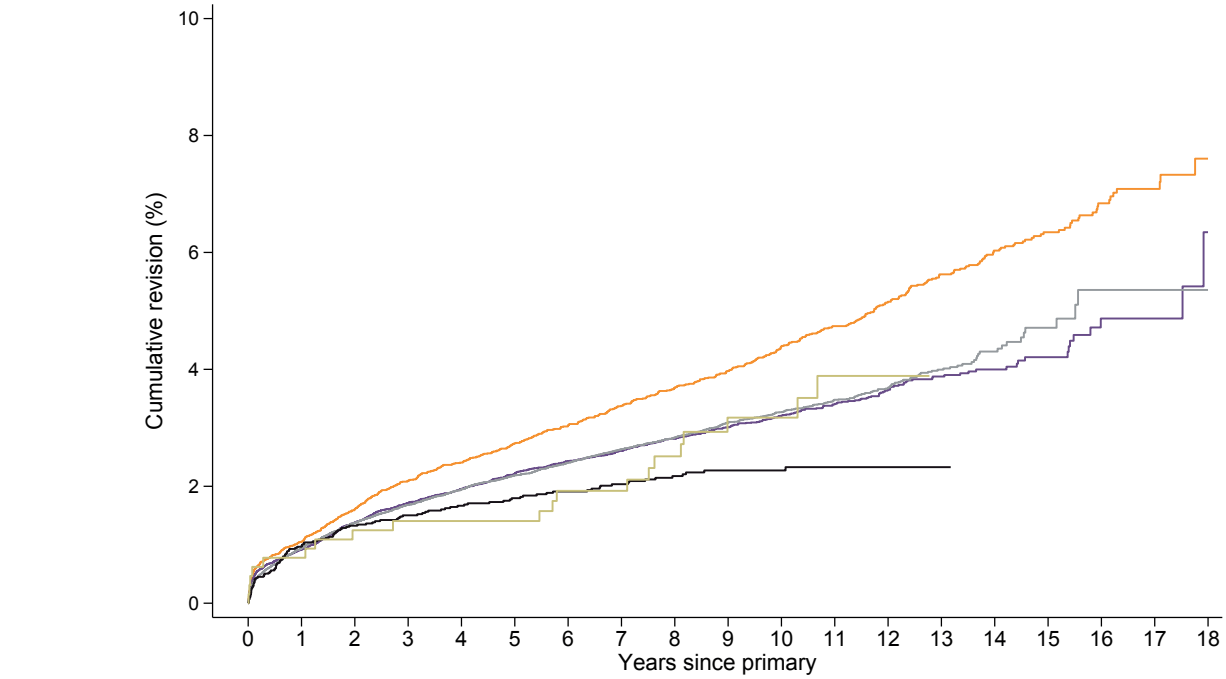
Figure 3.H10 (e) KM estimates of cumulative revision of primary uncemented CoP hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
28	28,634	25,918	22,131	18,133	14,540	11,223	8,053	5,082	2,264	386
32	62,662	48,637	31,709	18,632	9,712	4,564	1,701	616	*245*	*21*
36	43,453	31,658	20,576	11,610	5,599	2,182	751	*176*	*<4*	

For uncemented ceramic-on-polyethylene (CoP) hips (Figure 3.H10 (e)), there was a statistically significant difference between the three head sizes shown ($P<0.001$) with 28mm heads having higher revision rates than 32mm and 36mm heads.

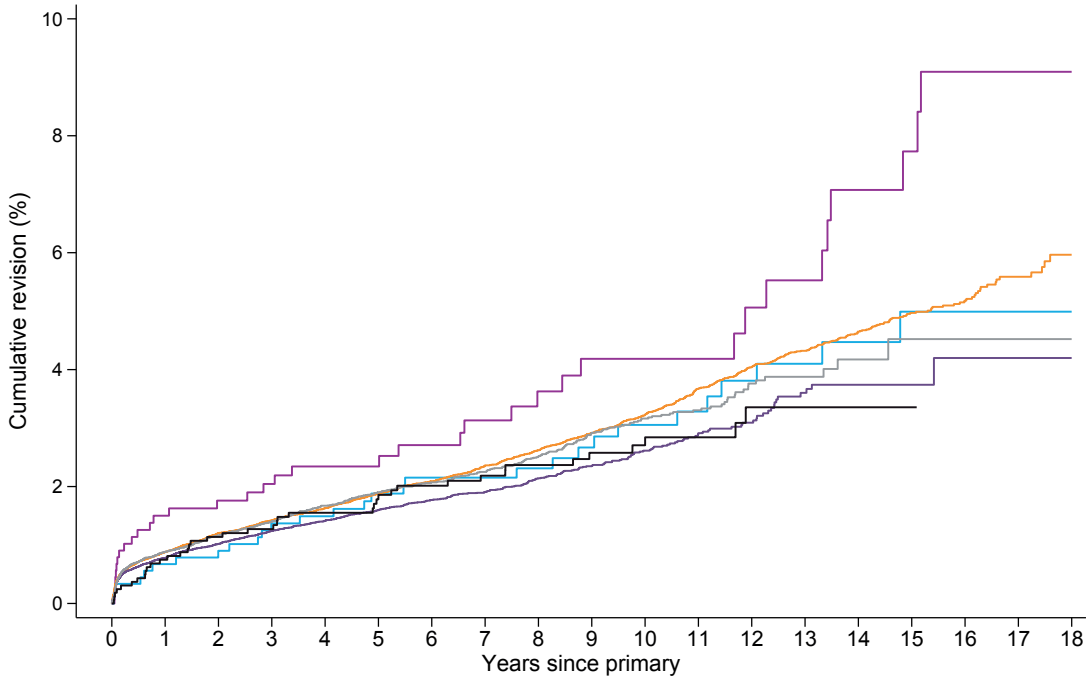
Figure 3.H10 (f) KM estimates of cumulative revision of primary uncemented CoC hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
28	13,704	13,144	12,371	11,479	10,234	8,428	6,177	3,929	1,713	*224*
32	37,586	34,985	30,843	25,524	19,244	12,014	5,844	2,308	619	*87*
36	79,869	74,363	66,095	54,525	39,335	22,781	8,922	1,956	*165*	*8*
40	5,553	5,129	4,706	4,113	3,263	1,791	309			
44	643	629	608	558	475	326	*52*			

Figure 3.H10 (f) shows revision rates for uncemented ceramic-on-ceramic (CoC) hip replacements by head size. There are statistically significant differences between all five head sizes shown (P<0.001). In the short-term, the larger the head size, the lower the revision rate of the construct, but revision rates begin to rise in 44mm heads after six years.

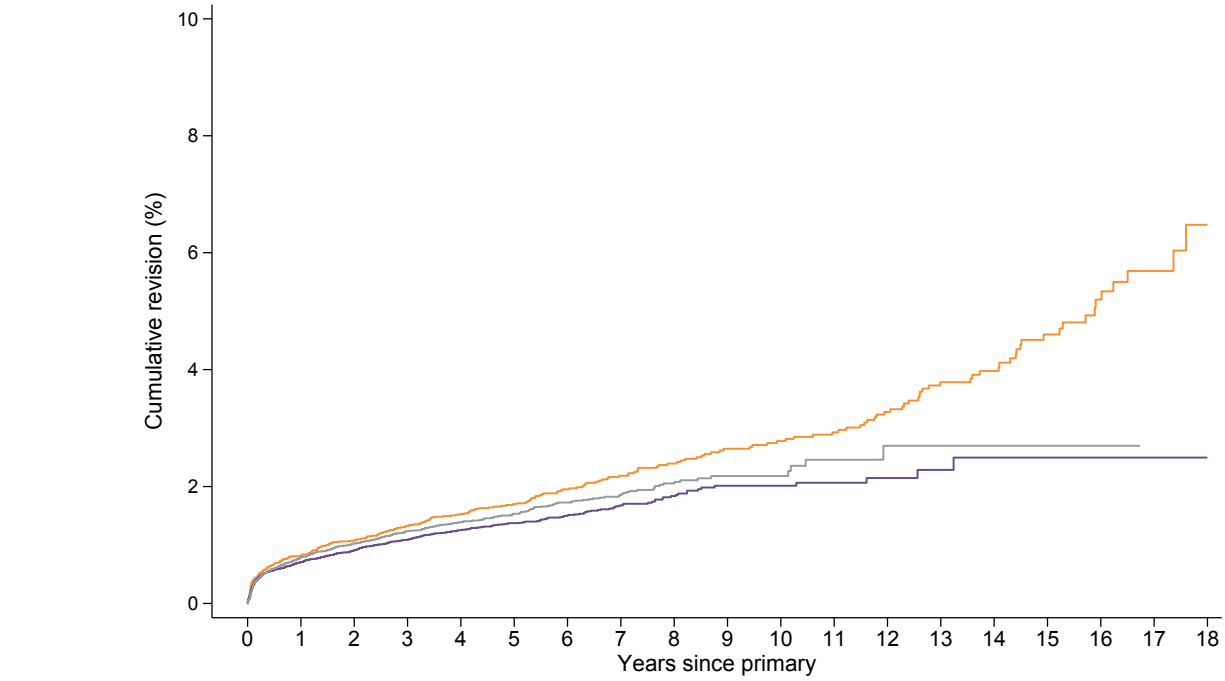
Figure 3.H10 (g) KM estimates of cumulative revision of primary hybrid MoP hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
22.25	893	738	612	489	371	282	*212*	*167*	*101*	*16*
26	892	865	784	699	588	448	337	*223*	*109*	*16*
28	48,014	44,114	38,359	31,604	25,112	19,173	13,485	7,933	3,195	468
32	78,562	62,375	41,749	24,863	12,955	6,088	2,530	731	*101*	*<4*
36	43,033	33,827	23,877	15,487	9,422	5,023	1,847	432	*62*	*6*
40	1,638	1,494	1,351	1,200	1,015	713	347	*74*		

Figure 3.H10 (g) shows revision rates for hybrid MoP hip replacements by head size. There was a statistically significant difference between the six head sizes shown (P<0.001) with 22.25mm heads having higher revision rates than the other heads. Beyond 12 years the numbers at risk are generally low so apparent differences should be interpreted with caution.

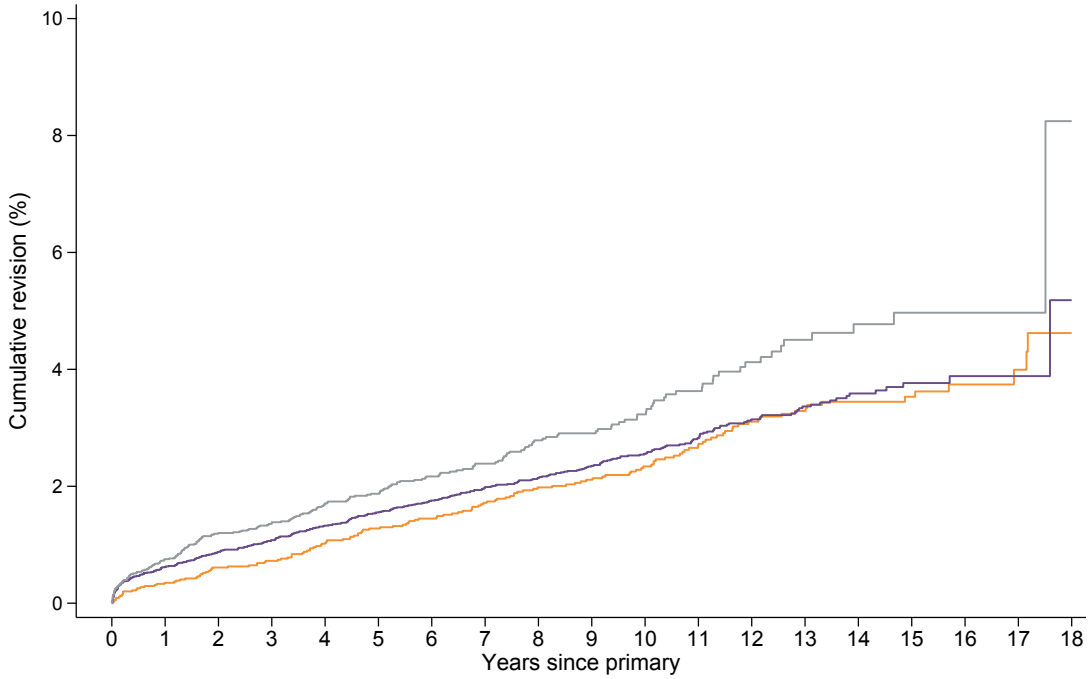
Figure 3.H10 (h) KM estimates of cumulative revision of primary hybrid CoP hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
28	13,399	11,189	8,165	5,571	3,745	2,791	2,075	1,367	674	*120*
32	54,455	37,970	21,587	10,656	4,542	2,120	994	270	*64*	*<4*
36	41,011	28,914	17,480	9,186	3,743	1,198	381	*46*	*6*	

Figure 3.H10 (h) shows revision rates for hybrid ceramic-on-polyethylene hip replacements by head size. Bearings with 28mm heads had higher revision rates than those with 32mm and 36mm heads (P<0.001).

Figure 3.H10 (i) KM estimates of cumulative revision of primary hybrid CoC hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
28	5,447	5,305	5,007	4,537	3,937	3,272	2,304	1,477	688	*98*
32	13,541	13,044	12,097	10,746	8,739	6,392	4,185	2,170	626	*26*
36	8,065	7,345	6,214	4,833	3,376	2,068	1,136	621	*201*	*9*

Figure 3.H10 (i) shows revision rates for hybrid ceramic-on-ceramic hip replacements by head size. Bearings with 36mm heads had a higher revision rate than 32mm and 28mm heads (P=0.002).

Figure 3.H10 (j) KM estimates of cumulative revision of primary reverse hybrid MoP hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

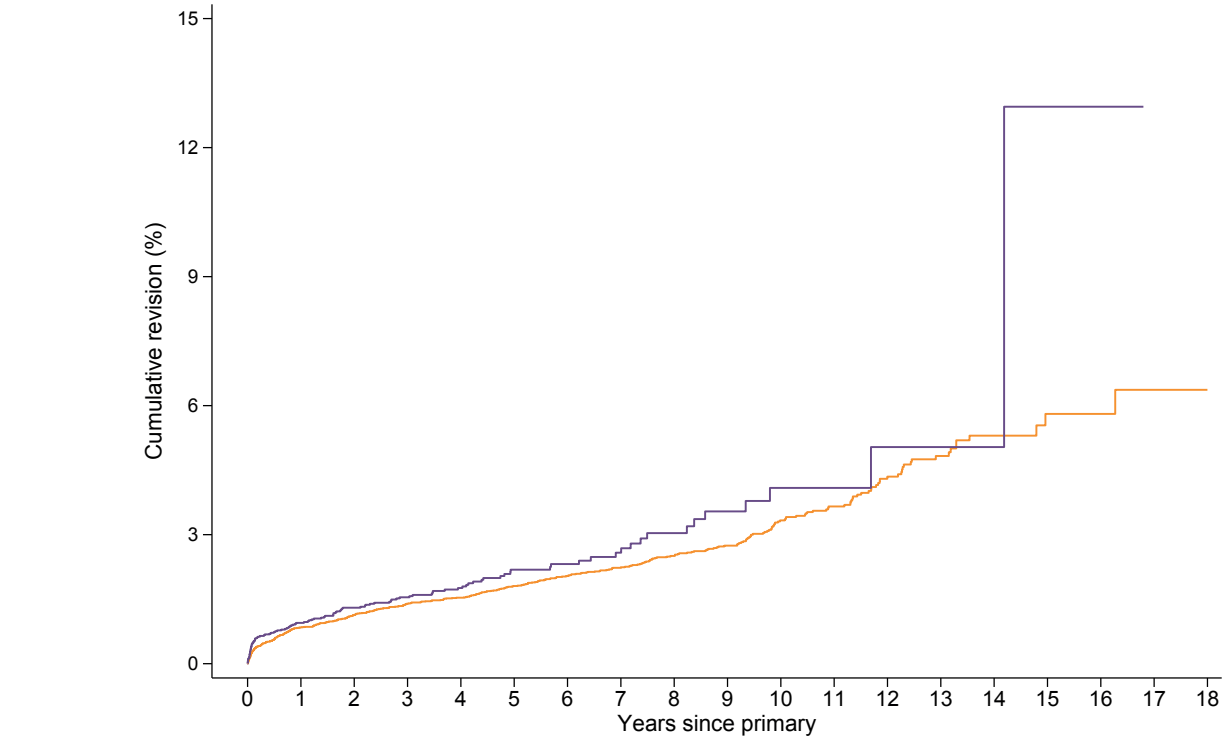
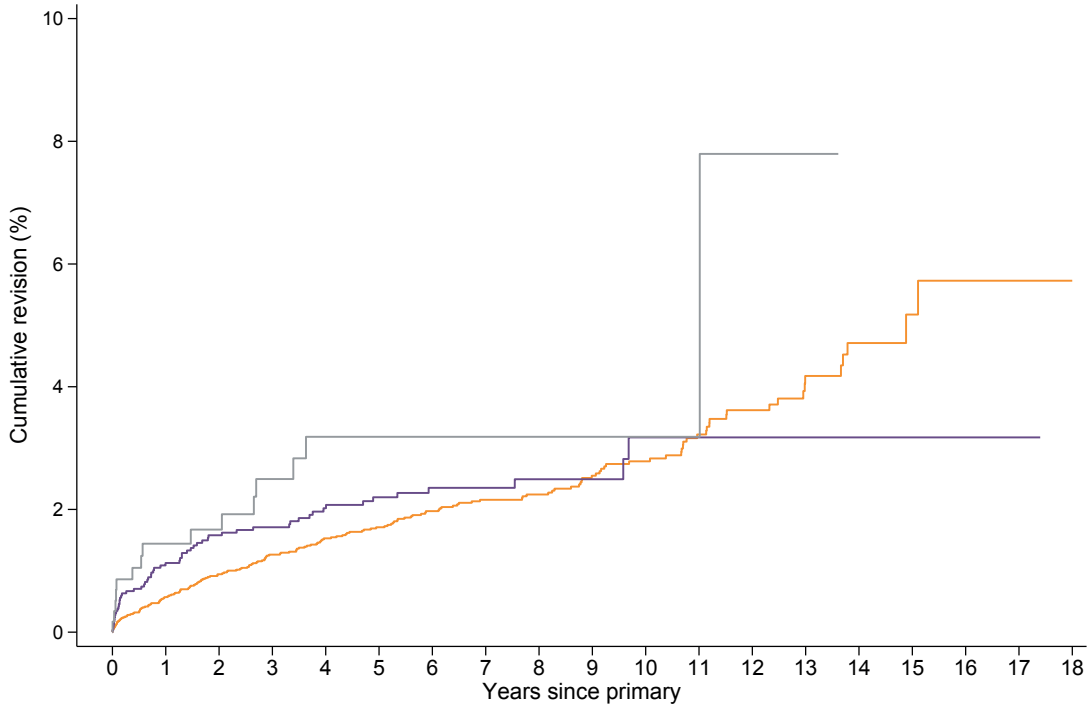


Figure 3.H10 (j) shows revision rates for reverse hybrid metal-on-polyethylene hip replacements by head size. There were no statistically significant differences in revision rates between head sizes (P=0.12).

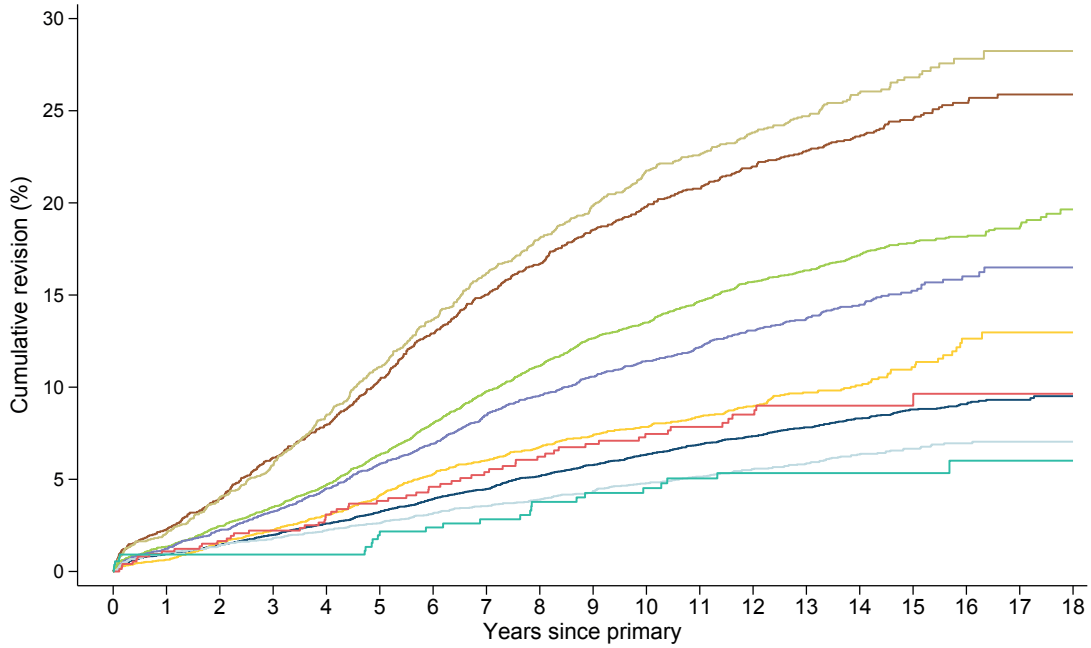
Figure 3.H10 (k) KM estimates of cumulative revision of primary reverse hybrid CoP hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
28	7,504	6,778	5,738	4,496	3,216	2,091	1,182	440	*110*	*19*
32	2,871	2,329	1,792	1,160	580	*220*	*47*	*15*	*4*	
36	582	394	258	*175*	*96*	*36*	*7*			

Figure 3.H10 (k) shows revision rates for reverse hybrid ceramic-on-polyethylene hip replacements by head size. There were no statistically significant differences in revision rates between head sizes (P=0.11).

Figure 3.H10 (l) KM estimates of cumulative revision of primary resurfacing MoM hip replacement by head size (mm). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
42	2,288	2,190	2,082	1,951	1,841	1,731	1,583	1,149	550	*108*
44	2,263	2,169	2,052	1,915	1,785	1,638	1,418	782	*242*	*30*
46	6,319	6,142	5,962	5,683	5,336	4,960	4,352	2,995	1,352	*222*
48	4,908	4,664	4,421	4,152	3,790	3,426	2,693	1,402	442	*51*
50	12,133	11,510	10,862	10,114	9,322	8,507	7,033	4,663	2,116	395
52	5,216	4,872	4,536	4,161	3,747	3,272	2,390	1,160	354	*35*
54	6,087	5,706	5,333	4,970	4,572	4,154	3,535	2,437	1,143	*197*
56	738	700	663	615	550	501	383	*209*	*74*	*4*
58	545	513	485	449	406	365	314	*230*	*119*	*12*

Figure 3.H10 (l) shows revision rates for resurfacing metal-on-metal hip replacements by head size. There is a strong trend to lower revision rates with larger head sizes (P<0.001).

3.2.4 Revisions after primary hip surgery for the main stem / cup brand combinations

As in previous reports, we include only stem / cup brand combinations with more than 2,500 procedures for cemented, uncemented, hybrid and reverse hybrid hips or more than 1,000 procedures in the case of resurfacings. The figures in blue italics are at time points where fewer than 250 cases remained at risk; no results are shown at all where the number had fallen below ten cases. No attempt has been made to adjust for other factors that may influence the chance of revision, so the figures are unadjusted cumulative probabilities of revision. Given that the sub-groups may differ in composition with respect to age and gender, the percentage of males and the median (IQR) of the ages are also shown in these tables.

Table 3.H7 shows Kaplan-Meier estimates of the cumulative percentage probability of revision of primary hip replacement (for any reason) for the main stem / cup brand constructs.

Table 3.H7 KM estimates of cumulative revision (95% CI) of primary hip replacement by fixation, and stem / cup brand. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Stem:cup brand	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Cemented									
C-Stem AMT Cemented Stem[St] : Charnley and Elite Plus LPW[C]	3,461	75 (70 to 79)	30	0.61 (0.40-0.94)	1.31 (0.97-1.76)	1.59 (1.21-2.09)	2.64 (2.07-3.37)	*4.05 (3.06-5.35)*	
C-Stem AMT Cemented Stem[St] : Elite Plus Ogee[C]	5,068	77 (72 to 81)	34	0.30 (0.18-0.50)	0.94 (0.69-1.27)	1.28 (0.98-1.69)	2.00 (1.54-2.59)	*2.82 (1.91-4.16)*	
C-Stem AMT Cemented Stem[St] : Marathon[C]	16,906	75 (70 to 80)	32	0.56 (0.46-0.70)	1.00 (0.85-1.18)	1.32 (1.13-1.55)	2.11 (1.66-2.68)		
C-Stem Cemented Stem[St] : Elite Plus Ogee[C]	6,223	72 (66 to 77)	39	0.41 (0.28-0.60)	0.89 (0.68-1.16)	1.18 (0.93-1.50)	2.56 (2.10-3.12)	4.40 (3.61-5.37)	*4.84 (3.88-6.04)*
C-Stem Cemented Stem[St] : Marathon[C]	10,122	68 (60 to 75)	41	0.45 (0.34-0.61)	0.90 (0.73-1.11)	1.31 (1.08-1.57)	2.02 (1.68-2.44)		
CPT CoCr Stem[St] : Elite Plus Ogee[C]	2,522	73 (67 to 79)	36	0.60 (0.36-0.99)	1.51 (1.09-2.07)	2.22 (1.70-2.89)	3.95 (3.17-4.91)	*5.47 (4.29-6.97)*	
CPT CoCr Stem[St] : ZCA[C]	18,403	77 (71 to 81)	31	0.91 (0.78-1.05)	1.51 (1.34-1.71)	2.14 (1.92-2.38)	4.00 (3.60-4.45)	5.50 (4.80-6.29)	*6.63 (5.25-8.35)*
Charnley Cemented Stem[St] : Charnley Cemented Cup[C]	4,700	72 (66 to 78)	38	0.32 (0.19-0.54)	1.12 (0.85-1.47)	1.82 (1.46-2.26)	3.68 (3.14-4.32)	6.09 (5.26-7.05)	*7.25 (6.14-8.55)*
Charnley Cemented Stem[St] : Charnley Ogee[C]	10,628	73 (67 to 78)	38	0.37 (0.27-0.51)	1.20 (1.01-1.44)	1.85 (1.61-2.14)	3.63 (3.26-4.05)	5.94 (5.35-6.60)	6.78 (6.02-7.62)
Charnley Cemented Stem[St] : Charnley and Elite Plus LPW[C]	7,117	74 (68 to 79)	29	0.38 (0.26-0.56)	0.76 (0.58-1.00)	1.15 (0.92-1.44)	2.46 (2.08-2.91)	3.88 (3.31-4.55)	*4.85 (3.93-5.98)*
Exeter V40[St] : Cenator Cemented Cup[C]	2,528	75 (69 to 80)	32	0.64 (0.39-1.04)	1.38 (0.99-1.93)	2.05 (1.55-2.70)	2.72 (2.11-3.49)	4.42 (3.45-5.64)	*6.00 (4.05-8.84)*
Exeter V40[St] : Charnley and Elite Plus LPW[C]	5,585	73 (68 to 79)	31	0.67 (0.49-0.92)	1.24 (0.97-1.57)	1.51 (1.21-1.88)	2.16 (1.75-2.66)	3.16 (2.39-4.16)	*3.83 (2.54-5.75)*

Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St]=Stem; [C]=Cup; [SL]=Shell liner.

Table 3.H7 (continued)

Stem:cup brand	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Exeter V40[St] : Elite Plus Cemented Cup[C]	5,261	73 (67 to 79)	32	0.33 (0.20-0.52)	0.64 (0.46-0.90)	0.88 (0.66-1.18)	1.46 (1.14-1.87)	2.91 (2.19-3.87)	*4.80 (2.83-8.07)*
Exeter V40[St] : Elite Plus Ogee[C]	27,116	74 (69 to 80)	35	0.38 (0.31-0.46)	0.85 (0.74-0.97)	1.20 (1.07-1.34)	2.16 (1.96-2.37)	3.19 (2.86-3.56)	*3.77 (3.25-4.36)*
Exeter V40[St] : Exeter Contemporary Flanged[C]	99,589	74 (69 to 80)	34	0.58 (0.53-0.63)	1.02 (0.96-1.08)	1.37 (1.30-1.45)	2.36 (2.23-2.49)	4.17 (3.87-4.50)	*5.13 (4.45-5.90)*
Exeter V40[St] : Exeter Contemporary Hooded[C]	29,260	75 (70 to 80)	32	0.95 (0.85-1.07)	1.61 (1.47-1.76)	2.12 (1.95-2.30)	3.94 (3.67-4.23)	7.11 (6.53-7.74)	*9.67 (8.16-11.43)*
Exeter V40[St] : Exeter Duration[C]	17,042	73 (67 to 79)	32	0.60 (0.49-0.73)	1.19 (1.04-1.37)	1.63 (1.44-1.83)	3.74 (3.43-4.08)	6.67 (6.10-7.28)	*9.03 (7.82-10.42)*
Exeter V40[St] : Exeter X3 Rimfit[C]	44,539	71 (64 to 78)	34	0.50 (0.44-0.57)	0.86 (0.77-0.96)	1.20 (1.09-1.32)	1.86 (1.61-2.15)		
Exeter V40[St] : Marathon[C]	9,468	72 (64 to 78)	35	0.50 (0.38-0.67)	0.83 (0.66-1.05)	1.09 (0.88-1.35)	1.50 (1.18-1.92)		
Exeter V40[St] : Opera[C]	2,846	74 (68 to 80)	32	0.39 (0.22-0.71)	0.84 (0.56-1.26)	1.27 (0.91-1.78)	3.08 (2.42-3.91)	6.71 (5.16-8.71)	*8.00 (6.01-10.61)*
MS-30[St] : Original ME Muller Low Profile Cup[C]	4,200	75 (69 to 81)	32	0.24 (0.13-0.45)	0.50 (0.32-0.78)	0.72 (0.49-1.05)	1.51 (1.10-2.07)	*3.28 (2.16-4.97)*	*3.71 (2.41-5.69)*
Muller Straight Stem[St] : Original ME Muller Low Profile Cup[C]	3,009	75 (70 to 80)	27	0.40 (0.23-0.71)	0.80 (0.53-1.20)	1.17 (0.83-1.66)	2.70 (2.06-3.53)	*5.14 (3.71-7.12)*	*7.22 (4.55-11.37)*
Stanmore Modular Stem[St] : Stanmore-Arcom Cup[C]	5,469	75 (70 to 80)	29	0.44 (0.30-0.66)	1.08 (0.83-1.39)	1.51 (1.21-1.89)	2.41 (1.99-2.92)	4.35 (3.54-5.35)	*5.64 (4.25-7.48)*
Uncemented									
Accolade[St] : Trident[SL]	27,279	66 (59 to 73)	44	0.94 (0.83-1.06)	1.89 (1.73-2.06)	2.51 (2.33-2.71)	3.97 (3.72-4.24)	5.62 (5.10-6.18)	*5.62 (5.10-6.18)*
Accolade II[St] : Trident[SL]	17,477	65 (57 to 72)	47	0.81 (0.68-0.96)	1.32 (1.14-1.53)	1.60 (1.36-1.88)			
Accolade II[St] : Tritanium[SL]	2,725	61 (53 to 70)	50	0.72 (0.46-1.15)	1.57 (1.09-2.26)	2.24 (1.60-3.13)			
Anthology[St] : R3 Cementless[SL]	5,174	62 (53 to 69)	42	1.08 (0.83-1.41)	1.66 (1.34-2.06)	2.05 (1.68-2.50)	3.18 (2.51-4.01)		
Corail[St] : ASR Resurfacing Cup[C]	2,776	61 (54 to 67)	55	0.97 (0.67-1.42)	7.35 (6.43-8.39)	23.40 (21.84-25.04)	43.66 (41.77-45.59)	48.44 (46.45-50.47)	
Corail[St] : Duraloc Cementless Cup[SL]	4,040	70 (64 to 75)	39	0.75 (0.52-1.06)	1.66 (1.31-2.11)	2.44 (2.00-2.98)	5.42 (4.72-6.21)	10.55 (9.38-11.85)	*12.84 (11.15-14.78)*
Corail[St] : Pinnacle Gription[SL]	14,794	66 (58 to 73)	42	0.86 (0.72-1.03)	1.47 (1.26-1.71)	2.03 (1.75-2.35)	*2.76 (2.23-3.42)*		
Corail[St] : Pinnacle[SL]	179,988	66 (59 to 73)	45	0.76 (0.72-0.80)	1.44 (1.38-1.50)	2.07 (2.00-2.14)	4.25 (4.12-4.38)	6.93 (6.63-7.24)	
Corail[St] : Trilogy[SL]	3,311	67 (61 to 74)	40	0.58 (0.37-0.91)	1.08 (0.77-1.50)	1.63 (1.24-2.14)	2.83 (2.26-3.54)	3.53 (2.73-4.56)	*7.84 (3.83-15.69)*

Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St]=Stem; [C]=Cup; [SL]=Shell liner.

Table 3.H7 (continued)

Stem:cup brand	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Furlong Evolution Cementless[St] : Furlong HAC CSF Plus[SL]	5,683	62 (52 to 70)	39	1.27 (1.00-1.60)	1.77 (1.45-2.17)	2.01 (1.66-2.44)			
Furlong HAC Stem[St] : CSF[SL]	17,256	69 (63 to 76)	40	1.10 (0.96-1.27)	1.82 (1.63-2.03)	2.21 (1.99-2.44)	3.53 (3.25-3.84)	5.06 (4.67-5.49)	5.78 (5.22-6.40)
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	25,078	66 (59 to 73)	45	1.09 (0.97-1.23)	1.73 (1.57-1.90)	2.00 (1.83-2.19)	2.62 (2.41-2.86)		
M/L Taper Cementless[St] : Continuum[SL]	6,338	61 (53 to 68)	49	1.22 (0.98-1.53)	1.78 (1.48-2.14)	2.13 (1.79-2.53)	2.76 (2.34-3.26)		
M/L Taper Cementless[St] : Trilogy IT[SL]	5,773	63 (55 to 71)	51	1.24 (0.99-1.57)	1.98 (1.65-2.39)	2.25 (1.88-2.69)	*2.97 (2.31-3.82)*		
Metafix Stem[St] : Trinity[SL]	8,047	64 (56 to 70)	46	0.70 (0.54-0.91)	1.03 (0.82-1.29)	1.29 (1.04-1.60)	2.07 (1.58-2.71)		
Polarstem Cementless[St] : R3 Cementless[SL]	22,895	65 (58 to 72)	47	0.71 (0.61-0.83)	0.96 (0.84-1.11)	1.18 (1.02-1.35)	1.99 (1.51-2.62)		
SL-Plus Cementless Stem[St] : EP-Fit Plus[SL]	3,815	66 (59 to 74)	43	1.45 (1.11-1.88)	3.12 (2.61-3.72)	4.47 (3.85-5.18)	7.20 (6.36-8.16)	9.35 (8.20-10.65)	
Synergy Cementless Stem[St] : R3 Cementless[SL]	4,014	65 (57 to 71)	52	0.90 (0.65-1.25)	1.29 (0.98-1.70)	1.67 (1.30-2.14)	2.71 (2.06-3.54)		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	27,294	65 (58 to 72)	44	1.09 (0.98-1.22)	1.49 (1.35-1.64)	1.76 (1.60-1.92)	2.27 (2.08-2.48)	*2.61 (2.26-3.02)*	
Taperloc Complete Cementless Stem[St] : Exceed ABT[SL]	3,831	63 (55 to 70)	49	0.84 (0.59-1.19)	1.35 (1.02-1.77)	1.59 (1.23-2.06)	*1.88 (1.45-2.44)*		
Taperloc Complete Cementless Stem[St] : G7 Cementless Acetabular Component[SL]	2,699	66 (57 to 73)	46	0.58 (0.35-0.95)	0.77 (0.49-1.22)	0.87 (0.55-1.37)			
miniHip[St] : Trinity[SL]	2,615	56 (49 to 63)	45	1.39 (1.01-1.93)	2.07 (1.58-2.71)	2.34 (1.81-3.03)	*3.08 (2.30-4.12)*		
Hybrid									
C-Stem AMT Cemented Stem[St] : Pinnacle Gription[SL]	4,263	73 (66 to 78)	36	0.87 (0.62-1.23)	1.28 (0.92-1.77)	1.71 (1.16-2.52)			
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	21,241	72 (65 to 77)	38	0.67 (0.57-0.79)	1.12 (0.98-1.28)	1.45 (1.27-1.65)	2.58 (2.16-3.08)	*2.99 (2.38-3.74)*	
CPCS[St] : R3 Cementless[SL]	5,788	74 (68 to 79)	32	0.86 (0.65-1.14)	1.45 (1.14-1.83)	1.79 (1.40-2.29)			
CPT CoCr Stem[St] : Continuum[SL]	12,578	70 (62 to 77)	37	1.48 (1.28-1.71)	2.11 (1.86-2.39)	2.52 (2.23-2.85)	3.69 (3.06-4.45)		

Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St]=Stem; [C]=Cup; [SL]=Shell liner.

Table 3.H7 (continued)

Stem:cup brand	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
CPT CoCr Stem[St] : Trabecular Metal Modular Cementless Cup[SL]	2,933	72 (64 to 79)	31	1.12 (0.79-1.58)	1.86 (1.42-2.45)	2.35 (1.83-3.02)	4.16 (3.25-5.32)	*5.66 (4.10-7.79)*	
CPT CoCr Stem[St] : Trilogy IT[SL]	13,312	69 (62 to 76)	38	1.17 (1.00-1.37)	1.76 (1.54-2.01)	2.12 (1.86-2.42)	*2.81 (2.28-3.47)*		
CPT CoCr Stem[St] : Trilogy[SL]	25,243	71 (65 to 78)	36	0.90 (0.79-1.02)	1.44 (1.29-1.60)	2.12 (1.93-2.32)	3.71 (3.40-4.06)	5.04 (4.51-5.62)	*5.40 (4.57-6.37)*
Exeter V40[St] : ABG II Cementless Cup[SL]	2,714	65 (59 to 73)	34	0.26 (0.12-0.54)	0.71 (0.45-1.11)	1.15 (0.80-1.64)	2.16 (1.64-2.85)	3.83 (3.03-4.85)	*4.54 (3.39-6.08)*
Exeter V40[St] : Pinnacle[SL]	10,310	72 (65 to 78)	39	0.78 (0.62-0.97)	1.14 (0.94-1.37)	1.40 (1.18-1.67)	2.52 (2.08-3.05)	*3.32 (2.64-4.16)*	
Exeter V40[St] : R3 Cementless[SL]	3,384	73 (65 to 78)	31	0.73 (0.49-1.08)	1.20 (0.87-1.65)	1.59 (1.17-2.15)	*2.14 (1.45-3.16)*		
Exeter V40[St] : Trident[SL]	126,367	69 (61 to 76)	39	0.63 (0.59-0.68)	1.07 (1.01-1.13)	1.40 (1.33-1.48)	2.39 (2.26-2.53)	3.60 (3.33-3.88)	*5.06 (3.56-7.16)*
Exeter V40[St] : Trilogy[SL]	15,005	70 (63 to 76)	40	0.56 (0.46-0.70)	0.88 (0.74-1.04)	1.22 (1.05-1.42)	2.13 (1.88-2.41)	3.21 (2.82-3.65)	*3.84 (3.22-4.57)*
Exeter V40[St] : Tritanium[SL]	7,880	68 (60 to 75)	45	1.09 (0.88-1.35)	1.64 (1.36-1.98)	2.04 (1.71-2.45)	3.03 (2.46-3.73)		
Taperfit Cemented Stem[St] : Trinity[SL]	7,739	72 (65 to 77)	34	0.95 (0.75-1.20)	1.42 (1.16-1.72)	1.61 (1.32-1.95)	*2.24 (1.64-3.07)*		
Reverse hybrid									
Corail[St] : Elite Plus Ogee[C]	3,175	72 (65 to 77)	37	0.67 (0.43-1.02)	1.46 (1.10-1.96)	1.85 (1.42-2.41)	2.88 (2.26-3.67)	*4.54 (3.49-5.89)*	
Corail[St] : Marathon[C]	17,767	70 (64 to 76)	39	0.62 (0.51-0.75)	1.04 (0.90-1.21)	1.29 (1.12-1.48)	2.11 (1.77-2.51)		
Resurfacing									
ASR Resurfacing Cup	2,958	55 (49 to 60)	68	1.62 (1.23-2.15)	5.83 (5.04-6.74)	13.16 (11.99-14.44)	26.10 (24.54-27.74)	30.13 (28.47-31.86)	
Adept Resurfacing Cup	3,956	54 (47 to 59)	76	1.08 (0.80-1.45)	2.37 (1.93-2.91)	4.33 (3.71-5.04)	7.73 (6.89-8.68)	10.56 (9.41-11.84)	
BHR Resurfacing Cup	23,684	55 (48 to 60)	76	0.99 (0.88-1.13)	2.26 (2.08-2.46)	3.48 (3.25-3.73)	7.26 (6.91-7.62)	10.26 (9.81-10.72)	11.30 (10.76-11.86)
Conserve Plus Resurfacing Cup	1,325	56 (50 to 61)	63	2.04 (1.40-2.96)	5.15 (4.08-6.49)	8.28 (6.91-9.90)	14.01 (12.23-16.02)	16.45 (14.45-18.68)	*17.28 (15.03-19.82)*
Cormet 2000 Resurfacing Cup	3,679	55 (48 to 60)	65	1.50 (1.15-1.94)	3.71 (3.14-4.37)	7.64 (6.83-8.55)	16.72 (15.54-17.98)	22.35 (20.95-23.83)	*24.51 (22.74-26.40)*
Durom Resurfacing Cup	1,709	55 (49 to 60)	70	1.35 (0.90-2.02)	3.58 (2.80-4.58)	5.47 (4.49-6.66)	8.48 (7.24-9.91)	10.36 (8.96-11.96)	
Recap Magnum	1,699	54 (49 to 59)	73	1.94 (1.39-2.72)	3.36 (2.60-4.34)	5.56 (4.57-6.77)	10.15 (8.79-11.70)	*13.40 (11.57-15.50)*	

Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St]=Stem; [C]=Cup; [SL]=Shell liner.

Table 3.H8 further divides the data by stratifying for bearing surface. This table shows the estimated cumulative percentage probability of revision for the resulting fixation / bearing sub-groups, provided there were more than 2,500 procedures for unipolar bearings, or more than 1,000 procedures for dual mobility bearings.

Table 3.H8 KM estimates of cumulative revision (95% CI) of primary hip replacement by fixation, stem / cup brand, and bearing. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
Cemented										
C-Stem AMT Cemented Stem[St] : Charnley and Elite Plus LPW[C]	MoP	3,429	75 (71 to 79)	30	0.62 (0.40-0.95)	1.32 (0.98-1.78)	1.60 (1.22-2.11)	2.67 (2.09-3.40)	*4.09 (3.09-5.40)*	
C-Stem AMT Cemented Stem[St] : Elite Plus Ogee[C]	MoP	4,336	77 (73 to 82)	33	0.31 (0.18-0.53)	0.95 (0.69-1.31)	1.30 (0.98-1.74)	2.08 (1.59-2.72)	*2.97 (1.99-4.41)*	
C-Stem AMT Cemented Stem[St] : Marathon[C]	MoP	13,586	77 (72 to 81)	32	0.54 (0.42-0.68)	1.01 (0.84-1.21)	1.37 (1.15-1.64)	1.95 (1.56-2.43)		
C-Stem AMT Cemented Stem[St] : Marathon[C]	CoP	3,320	66 (60 to 72)	36	0.68 (0.44-1.04)	0.94 (0.64-1.38)	1.09 (0.75-1.59)	*2.43 (1.38-4.27)*		
C-Stem Cemented Stem[St] : Elite Plus Ogee[C]	MoP	5,221	73 (68 to 78)	38	0.47 (0.31-0.70)	1.00 (0.75-1.32)	1.30 (1.01-1.67)	2.83 (2.30-3.48)	4.88 (3.96-6.00)	*5.41 (4.27-6.85)*
C-Stem Cemented Stem[St] : Marathon[C]	MoP	5,695	73 (68 to 78)	37	0.38 (0.25-0.58)	0.81 (0.60-1.09)	1.17 (0.90-1.51)	1.96 (1.50-2.56)		
C-Stem Cemented Stem[St] : Marathon[C]	CoP	4,427	59 (52 to 65)	46	0.55 (0.37-0.82)	1.02 (0.75-1.38)	1.49 (1.14-1.94)	2.12 (1.63-2.76)		
CPT CoCr Stem[St] : ZCA[C]	MoP	17,171	77 (72 to 82)	30	0.96 (0.82-1.11)	1.58 (1.39-1.78)	2.22 (1.99-2.48)	4.12 (3.70-4.59)	5.51 (4.81-6.32)	*6.44 (5.10-8.12)*
Charnley Cemented Stem[St] : Charnley Cemented Cup[C]	MoP	4,700	72 (66 to 78)	38	0.32 (0.19-0.54)	1.12 (0.85-1.47)	1.82 (1.46-2.26)	3.68 (3.14-4.32)	6.09 (5.26-7.05)	*7.25 (6.14-8.55)*
Charnley Cemented Stem[St] : Charnley Ogee[C]	MoP	10,628	73 (67 to 78)	38	0.37 (0.27-0.51)	1.20 (1.01-1.44)	1.85 (1.61-2.14)	3.63 (3.26-4.05)	5.94 (5.35-6.60)	6.78 (6.02-7.62)
Charnley Cemented Stem[St] : Charnley and Elite Plus LPW[C]	MoP	7,117	74 (68 to 79)	29	0.38 (0.26-0.56)	0.76 (0.58-1.00)	1.15 (0.92-1.44)	2.46 (2.08-2.91)	3.88 (3.31-4.55)	*4.85 (3.93-5.98)*
Exeter V40[St] : Charnley and Elite Plus LPW[C]	MoP	4,405	75 (71 to 80)	28	0.71 (0.50-1.01)	1.24 (0.95-1.63)	1.50 (1.17-1.93)	2.36 (1.87-2.98)	3.59 (2.67-4.82)	*4.37 (2.86-6.65)*
Exeter V40[St] : Elite Plus Cemented Cup[C]	MoP	4,958	74 (68 to 79)	32	0.35 (0.21-0.55)	0.62 (0.43-0.89)	0.83 (0.60-1.13)	1.39 (1.07-1.81)	2.53 (1.87-3.41)	*4.61 (2.54-8.29)*
Exeter V40[St] : Elite Plus Ogee[C]	MoP	24,386	75 (70 to 80)	34	0.37 (0.30-0.45)	0.85 (0.74-0.98)	1.19 (1.06-1.34)	2.15 (1.94-2.38)	3.22 (2.87-3.61)	*3.77 (3.23-4.39)*
Exeter V40[St] : Elite Plus Ogee[C]	CoP	2,730	67 (61 to 73)	41	0.50 (0.29-0.86)	0.83 (0.54-1.27)	1.25 (0.86-1.80)	2.19 (1.59-3.02)	*2.82 (2.02-3.93)*	*3.79 (2.17-6.59)*

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St]=Stem; [C]=Cup; [SL]=Shell liner.

Table 3.H8 (continued)

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
Exeter V40[St] : Exeter Contemporary Flanged[C]	MoP	91,863	75 (70 to 80)	34	0.58 (0.53-0.63)	1.02 (0.96-1.09)	1.38 (1.30-1.46)	2.38 (2.25-2.52)	4.17 (3.86-4.51)	*5.05 (4.34-5.88)*
Exeter V40[St] : Exeter Contemporary Flanged[C]	CoP	7,726	67 (61 to 72)	36	0.58 (0.43-0.78)	0.99 (0.79-1.25)	1.34 (1.09-1.65)	2.10 (1.72-2.57)	*4.18 (3.17-5.50)*	
Exeter V40[St] : Exeter Contemporary Hooded[C]	MoP	27,338	76 (70 to 81)	32	0.97 (0.86-1.09)	1.62 (1.47-1.78)	2.13 (1.96-2.32)	3.93 (3.65-4.23)	7.11 (6.51-7.76)	*9.76 (8.12-11.72)*
Exeter V40[St] : Exeter Duration[C]	MoP	16,061	74 (68 to 79)	32	0.61 (0.50-0.75)	1.22 (1.06-1.40)	1.67 (1.48-1.88)	3.80 (3.47-4.15)	6.69 (6.11-7.33)	*9.36 (8.02-10.92)*
Exeter V40[St] : Exeter X3 Rimfit[C]	MoP	31,453	74 (68 to 80)	32	0.50 (0.43-0.59)	0.86 (0.75-0.97)	1.18 (1.05-1.33)	1.94 (1.60-2.34)		
Exeter V40[St] : Exeter X3 Rimfit[C]	CoP	13,086	63 (57 to 70)	37	0.49 (0.38-0.63)	0.86 (0.71-1.05)	1.23 (1.03-1.47)	1.71 (1.41-2.08)		
Exeter V40[St] : Marathon[C]	MoP	6,604	75 (70 to 80)	33	0.58 (0.42-0.79)	0.92 (0.70-1.20)	1.13 (0.88-1.46)	1.63 (1.22-2.19)		
Exeter V40[St] : Marathon[C]	CoP	2,864	63 (57 to 68)	39	0.33 (0.17-0.63)	0.63 (0.38-1.02)	0.99 (0.65-1.52)	*1.21 (0.78-1.87)*		
Exeter V40[St] : Opera[C]	MoP	2,713	75 (69 to 80)	31	0.37 (0.20-0.69)	0.84 (0.56-1.28)	1.30 (0.93-1.83)	3.14 (2.46-4.01)	6.63 (5.09-8.62)	*7.93 (5.95-10.53)*
MS-30[St] : Original ME Muller Low Profile Cup[C]	CoP	2,680	71 (66 to 76)	31	0.19 (0.08-0.45)	0.51 (0.30-0.88)	0.65 (0.40-1.06)	1.30 (0.86-1.96)	*3.52 (2.13-5.80)*	*4.10 (2.46-6.81)*
Stanmore Modular Stem[St] : Stanmore-Arcom Cup[C]	MoP	4,993	75 (70 to 81)	30	0.40 (0.26-0.63)	1.08 (0.82-1.41)	1.56 (1.24-1.96)	2.50 (2.05-3.04)	4.19 (3.36-5.21)	*4.83 (3.70-6.31)*
Uncemented										
Accolade[St] : Trident[SL]	MoP	12,496	71 (64 to 76)	41	0.96 (0.81-1.15)	1.95 (1.72-2.21)	2.67 (2.40-2.98)	4.82 (4.41-5.28)	*8.22 (6.78-9.95)*	
Accolade[St] : Trident[SL]	CoP	7,357	61 (55 to 67)	46	0.83 (0.65-1.07)	1.60 (1.34-1.92)	1.93 (1.63-2.28)	2.53 (2.14-2.99)	*3.27 (2.21-4.84)*	
Accolade[St] : Trident[SL]	CoC	7,371	62 (55 to 68)	46	1.01 (0.80-1.26)	2.05 (1.75-2.40)	2.77 (2.42-3.18)	3.78 (3.36-4.26)	4.54 (3.97-5.18)	*4.54 (3.97-5.18)*
Accolade II[St] : Trident[SL]	MoP	5,588	70 (64 to 76)	44	0.93 (0.71-1.23)	1.39 (1.10-1.77)	1.62 (1.26-2.07)			
Accolade II[St] : Trident[SL]	CoP	11,043	62 (55 to 69)	48	0.78 (0.62-0.97)	1.34 (1.11-1.63)	1.59 (1.28-1.96)			
Anthology[St] : R3 Cementless[SL]	MoP	4,128	63 (55 to 70)	39	1.14 (0.85-1.52)	1.73 (1.36-2.19)	2.00 (1.60-2.50)	2.52 (1.89-3.36)		
Corail[St] : ASR Resurfacing Cup[C]	MoM	2,776	61 (54 to 67)	55	0.97 (0.67-1.42)	7.35 (6.43-8.39)	23.40 (21.84-25.04)	43.66 (41.77-45.59)	48.44 (46.45-50.47)	
Corail[St] : Duraloc Cementless Cup[SL]	MoP	3,715	70 (65 to 75)	39	0.62 (0.41-0.93)	1.45 (1.11-1.90)	2.28 (1.83-2.82)	5.30 (4.58-6.13)	10.18 (8.96-11.56)	*12.84 (10.91-15.08)*
Corail[St] : Pinnacle Gription[SL]	MoP	5,357	73 (68 to 79)	37	1.08 (0.83-1.42)	1.61 (1.27-2.03)	2.08 (1.65-2.63)	*2.78 (2.12-3.64)*		
Corail[St] : Pinnacle Gription[SL]	CoP	6,861	63 (56 to 69)	45	0.53 (0.37-0.75)	1.18 (0.90-1.54)	1.45 (1.10-1.90)	*1.83 (1.31-2.53)*		

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St]=Stem; [C]=Cup; [SL]=Shell liner.

Table 3.H8 (continued)

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
Corail[St] : Pinnacle Gription[SL]	CoC	2,567	58 (49 to 65)	45	1.20 (0.84-1.72)	1.87 (1.40-2.49)	2.82 (2.19-3.63)	*3.68 (2.69-5.01)*		
Corail[St] : Pinnacle[SL]	MoP	71,294	71 (65 to 77)	41	0.78 (0.72-0.85)	1.26 (1.18-1.35)	1.54 (1.45-1.64)	2.66 (2.50-2.83)	4.48 (4.03-4.98)	
Corail[St] : Pinnacle[SL]	MoM	11,946	67 (60 to 74)	47	0.87 (0.72-1.06)	2.44 (2.18-2.74)	5.17 (4.78-5.59)	13.32 (12.68-13.98)	17.75 (16.93-18.60)	
Corail[St] : Pinnacle[SL]	CoP	50,583	63 (57 to 70)	47	0.66 (0.59-0.73)	1.05 (0.96-1.15)	1.41 (1.30-1.53)	2.38 (2.14-2.65)	*3.56 (2.89-4.38)*	
Corail[St] : Pinnacle[SL]	CoC	44,329	59 (52 to 66)	49	0.83 (0.75-0.92)	1.75 (1.63-1.88)	2.38 (2.24-2.53)	3.71 (3.52-3.92)	5.45 (4.98-5.97)	
Furlong Evolution Cementless[St] : Furlong HAC CSF Plus[SL]	CoC	4,915	60 (50 to 69)	39	1.17 (0.90-1.52)	1.61 (1.28-2.02)	1.90 (1.53-2.35)			
Furlong HAC Stem[St] : CSF[SL]	MoP	8,152	73 (67 to 78)	39	1.36 (1.13-1.64)	2.17 (1.87-2.51)	2.51 (2.18-2.88)	4.14 (3.69-4.65)	5.68 (5.04-6.40)	*7.13 (5.78-8.79)*
Furlong HAC Stem[St] : CSF[SL]	CoP	7,419	67 (61 to 73)	41	0.78 (0.61-1.01)	1.37 (1.12-1.66)	1.76 (1.48-2.09)	2.70 (2.33-3.12)	4.11 (3.58-4.71)	4.65 (3.99-5.41)
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	MoP	5,981	74 (69 to 79)	40	1.64 (1.34-1.99)	2.30 (1.94-2.71)	2.78 (2.38-3.25)	3.87 (3.31-4.51)		
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	CoP	3,510	67 (62 to 72)	46	0.90 (0.63-1.27)	1.52 (1.16-2.00)	1.75 (1.35-2.27)	2.54 (1.98-3.27)		
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	CoC	15,587	63 (56 to 69)	47	0.92 (0.78-1.09)	1.56 (1.37-1.77)	1.76 (1.57-1.99)	2.22 (1.98-2.48)		
Metafix Stem[St] : Trinity[SL]	CoP	3,876	64 (57 to 70)	47	0.61 (0.40-0.93)	0.83 (0.57-1.21)	1.08 (0.75-1.57)	*1.22 (0.82-1.81)*		
Metafix Stem[St] : Trinity[SL]	CoC	2,959	60 (52 to 66)	45	0.72 (0.47-1.11)	1.06 (0.75-1.52)	1.31 (0.94-1.83)	2.11 (1.50-2.98)		
Polarstem Cementless[St] : R3 Cementless[SL]	MoP	20,924	66 (58 to 73)	46	0.73 (0.62-0.86)	0.99 (0.85-1.14)	1.22 (1.05-1.41)	*2.14 (1.59-2.89)*		
Synergy Cementless Stem[St] : R3 Cementless[SL]	MoP	3,199	66 (58 to 72)	51	0.95 (0.66-1.35)	1.22 (0.89-1.67)	1.45 (1.08-1.94)	*1.77 (1.34-2.35)*		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	MoP	8,643	72 (66 to 77)	40	1.30 (1.08-1.57)	1.80 (1.53-2.10)	2.06 (1.77-2.39)	2.74 (2.36-3.19)		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	CoP	6,066	65 (58 to 71)	45	0.78 (0.59-1.04)	0.99 (0.77-1.28)	1.14 (0.89-1.45)	1.58 (1.23-2.04)		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	CoC	12,572	61 (54 to 67)	47	1.10 (0.93-1.29)	1.52 (1.32-1.75)	1.83 (1.60-2.08)	2.27 (2.00-2.58)	*2.61 (2.18-3.14)*	

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St]=Stem; [C]=Cup; [SL]=Shell liner.

Table 3.H8 (continued)

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
Hybrid										
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	MoP	11,021	76 (71 to 80)	34	0.70 (0.56-0.88)	1.23 (1.03-1.47)	1.59 (1.33-1.89)	2.38 (1.86-3.03)	*2.60 (1.97-3.42)*	
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	CoP	8,327	67 (61 to 72)	42	0.65 (0.50-0.85)	0.95 (0.76-1.21)	1.06 (0.83-1.34)	*1.74 (1.12-2.70)*		
CPCS[St] : R3 Cementless[SL]	MoP	5,367	74 (69 to 80)	31	0.84 (0.62-1.12)	1.46 (1.14-1.86)	1.73 (1.33-2.24)			
CPT CoCr Stem[St] : Continuum[SL]	MoP	6,392	75 (70 to 80)	34	1.57 (1.29-1.91)	2.15 (1.81-2.56)	2.59 (2.18-3.08)	*4.25 (3.03-5.94)*		
CPT CoCr Stem[St] : Continuum[SL]	CoP	4,688	65 (59 to 71)	40	1.40 (1.10-1.79)	2.06 (1.66-2.55)	2.26 (1.83-2.80)	*2.37 (1.90-2.96)*		
CPT CoCr Stem[St] : Trilogy IT[SL]	MoP	6,117	74 (69 to 79)	35	1.45 (1.18-1.79)	2.08 (1.74-2.50)	2.51 (2.10-3.00)			
CPT CoCr Stem[St] : Trilogy IT[SL]	CoP	5,833	66 (59 to 72)	40	0.92 (0.70-1.21)	1.55 (1.24-1.95)	1.93 (1.55-2.42)			
CPT CoCr Stem[St] : Trilogy[SL]	MoP	14,915	73 (67 to 79)	35	0.91 (0.77-1.08)	1.50 (1.32-1.72)	2.29 (2.05-2.56)	4.09 (3.71-4.52)	5.39 (4.80-6.05)	*5.80 (4.87-6.90)*
CPT CoCr Stem[St] : Trilogy[SL]	CoP	9,805	69 (62 to 75)	37	0.89 (0.72-1.09)	1.35 (1.13-1.61)	1.84 (1.56-2.16)	*2.46 (2.06-2.93)*	*2.46 (2.06-2.93)*	
Exeter V40[St] : Pinnacle[SL]	MoP	6,509	75 (70 to 80)	31	0.83 (0.63-1.08)	1.21 (0.97-1.52)	1.51 (1.23-1.86)	2.48 (2.00-3.08)	*3.29 (2.53-4.26)*	
Exeter V40[St] : Pinnacle[SL]	CoP	3,529	66 (59 to 71)	53	0.60 (0.39-0.93)	0.85 (0.59-1.25)	1.00 (0.69-1.43)	2.46 (1.52-3.96)		
Exeter V40[St] : R3 Cementless[SL]	MoP	2,532	75 (69 to 79)	29	0.80 (0.52-1.25)	1.36 (0.97-1.93)	1.69 (1.22-2.34)	*2.27 (1.53-3.37)*		
Exeter V40[St] : Trident[SL]	MoP	62,471	74 (68 to 79)	37	0.67 (0.61-0.74)	1.14 (1.05-1.23)	1.46 (1.36-1.57)	2.50 (2.31-2.71)	3.75 (3.34-4.21)	
Exeter V40[St] : Trident[SL]	CoP	47,838	65 (58 to 72)	41	0.59 (0.52-0.66)	0.93 (0.84-1.03)	1.18 (1.07-1.31)	1.82 (1.59-2.09)	*2.92 (2.06-4.13)*	
Exeter V40[St] : Trident[SL]	CoC	13,145	59 (53 to 65)	44	0.53 (0.42-0.67)	1.06 (0.90-1.25)	1.55 (1.35-1.77)	2.66 (2.38-2.97)	3.88 (3.47-4.34)	*5.79 (3.79-8.80)*
Exeter V40[St] : Trident[SL]*	MoPoM	1,961	75 (68 to 81)	33	1.10 (0.71-1.70)	1.71 (1.16-2.52)	1.85 (1.25-2.71)			
Exeter V40[St] : Trilogy[SL]	MoP	12,069	71 (65 to 77)	40	0.55 (0.43-0.70)	0.86 (0.71-1.04)	1.23 (1.04-1.45)	2.15 (1.87-2.47)	3.25 (2.81-3.76)	*3.79 (3.12-4.59)*
Exeter V40[St] : Trilogy[SL]	CoP	2,797	63 (57 to 69)	43	0.57 (0.35-0.94)	0.95 (0.64-1.39)	1.18 (0.84-1.67)	1.99 (1.50-2.65)	3.03 (2.27-4.04)	*3.93 (2.65-5.81)*
Exeter V40[St] : Tritanium[SL]	CoP	4,476	65 (58 to 71)	47	1.08 (0.81-1.45)	1.61 (1.25-2.06)	2.02 (1.58-2.58)	*3.08 (2.19-4.31)*		
Taperfit Cemented Stem[St] : Trinity[SL]	MoP	3,732	75 (71 to 80)	33	1.10 (0.81-1.50)	1.62 (1.25-2.11)	1.78 (1.37-2.30)	*2.47 (1.60-3.82)*		
Taperfit Cemented Stem[St] : Trinity[SL]	CoP	3,053	69 (62 to 74)	35	0.88 (0.60-1.30)	1.39 (1.00-1.92)	1.58 (1.15-2.17)			
Reverse hybrid										
Corail[St] : Marathon[C]	MoP	12,376	73 (68 to 78)	38	0.65 (0.52-0.81)	1.05 (0.87-1.25)	1.30 (1.10-1.55)	2.27 (1.84-2.81)		
Corail[St] : Marathon[C]	CoP	5,391	63 (56 to 68)	41	0.54 (0.38-0.79)	1.03 (0.78-1.36)	1.25 (0.97-1.62)	1.79 (1.31-2.45)		

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St]=Stem; [C]=Cup; [SL]=Shell liner.

3.2.5 Revisions for different indications after primary hip replacement

Overall, 40,387 (3.0%) of the 1,344,357 primary hip replacements had an associated first revision. The most common indications for revision were aseptic loosening (9,962), dislocation / subluxation (7,028), periprosthetic fracture (6,355), infection (6,159), adverse soft tissue reaction to particulate debris (5,991, a figure that is likely to be an underestimate due to changes in MDS collection, see later), and pain (5,019). Pain was not usually cited alone; in 3,410 out of the 5,019 instances (67.9%), it was cited together with one or more other indications. Associated PTIRs for these and the other indications are shown in Table 3.H9 (page 99). Here, implant wear denotes wear of the polyethylene component, wear of the acetabular component or dissociation of the liner.

The number of adverse reactions to particulate debris is likely to be underestimated because this was not requested (i.e. it was not available as an indication for revision) on the revision data collection forms in the early phase of the registry, i.e. was not included in MDSv1 and MDSv2. Some of these cases may have recorded the indication for revision as 'other' but this is not definitively known. Adoption of the later revision report forms (MDSv3 onwards) was staggered over time and so a small number of revisions associated with a few primaries as late as 2011 still had revisions reported on MDSv1 and MDSv2 of the data collection forms. Restricting our analyses to primaries from 2008 onwards, as done in recent annual reports, ensures that >99% of revisions were recorded on later forms (MDSv3 onwards). It was noted that only 2,796 of the 5,991 instances (46.7%) of adverse reactions to particulate debris would thus be included, i.e. 3,195 of the earlier cases are therefore missing. Therefore, two sets of PTIRs are presented: one set for all primary hip replacements, which are likely to be underestimates, and the other set for all primary hip replacements performed since the beginning of 2008, which has better ascertainment but does not include the cases with the longest follow-up.

Table 3.H9 reports revision by indication with further breakdowns by hip fixation and bearing. Metal-on-metal (irrespective of the type of fixation) and resurfacings seem to have the highest PTIRs for both aseptic loosening and pain but ceramic-on-metal has similar rates. Metal-on-metal bearings have the highest incidence of adverse reaction to particulate debris. Although the numbers are relatively small in comparison to other groups, dual mobility bearings appear to have PTIRs for revision for dislocation / subluxation that are higher than or similar to alternative bearings and higher PTIRs for revision for periprosthetic fracture and infection. It is not yet known how much selection accounts for these observations.

Table 3.H9 PTIR estimates of indications for hip revision (95% CI) by fixation and bearing.

Fixation and bearing surface	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Aseptic loosening	Pain	Dislocation/ Subluxation	Infection	Peripros-thetic fracture	Malalign-ment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Adverse reaction to particulate debris**	Adverse reaction to particulate debris for primaries from 1.1.2008*** Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years
All cases*	9,223.7	4.38 (4.34-4.42)	1.08 (1.06-1.10)	0.54 (0.53-0.56)	0.76 (0.74-0.78)	0.67 (0.65-0.68)	0.69 (0.67-0.71)	0.29 (0.28-0.30)	0.26 (0.25-0.27)	0.25 (0.24-0.26)	0.14 (0.13-0.15)	0.03 (0.03-0.03)	0.65 (0.63-0.67)	6,835.2	0.41 (0.39-0.42)
All cemented	2,956.1	3.15 (3.09-3.22)	1.05 (1.02-1.09)	0.23 (0.21-0.24)	0.77 (0.74-0.81)	0.64 (0.61-0.67)	0.53 (0.51-0.56)	0.17 (0.16-0.18)	0.22 (0.20-0.23)	0.18 (0.17-0.20)	0.08 (0.07-0.09)	0.01 (0.01-0.02)	0.03 (0.03-0.04)	1,975.0	0.02 (0.02-0.03)
Cemented and															
MoP	2,594.9	3.21 (3.14-3.28)	1.09 (1.05-1.13)	0.23 (0.21-0.25)	0.80 (0.76-0.83)	0.63 (0.60-0.66)	0.54 (0.52-0.57)	0.18 (0.16-0.19)	0.22 (0.21-0.24)	0.19 (0.18-0.21)	0.07 (0.06-0.08)	0.01 (0.01-0.02)	0.03 (0.02-0.04)	1,688.7	0.02 (0.02-0.03)
MoM	4.5	6.24 (4.31-9.03)	2.00 (1.04-3.85)	0.22 (0.03-1.58)	1.11 (0.46-2.68)	0.67 (0.22-2.07)	0.89 (0.33-2.37)	0.00 (.-.)	1.11 (0.46-2.68)	0.67 (0.22-2.07)	0.89 (0.33-2.37)	0.00 (.-.)	0.89 (0.33-2.37)	1.0	0.00 (.-.)
CoP	346.2	2.62 (2.46-2.80)	0.78 (0.69-0.88)	0.18 (0.14-0.23)	0.59 (0.51-0.67)	0.67 (0.59-0.77)	0.38 (0.32-0.45)	0.13 (0.10-0.17)	0.16 (0.12-0.21)	0.11 (0.08-0.15)	0.10 (0.08-0.14)	0.00 (0.00-0.02)	0.03 (0.02-0.06)	274.8	0.03 (0.02-0.06)
MoPoM	9.6	6.25 (4.85-8.05)	0.94 (0.49-1.80)	0.21 (0.05-0.83)	1.15 (0.63-2.07)	1.77 (1.10-2.85)	2.29 (1.51-3.48)	0.10 (0.01-0.74)	0.10 (0.01-0.74)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	9.6	0.00 (.-.)
CoPoM	0.8	5.16 (1.94-13.74)	1.29 (0.18-9.15)	0.00 (.-.)	1.29 (0.18-9.15)	0.00 (.-.)	2.58 (0.64-10.31)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.8	0.00 (.-.)
All uncemented	3,462.1	5.05 (4.98-5.13)	1.22 (1.18-1.26)	0.66 (0.63-0.68)	0.75 (0.72-0.78)	0.65 (0.63-0.68)	0.67 (0.65-0.70)	0.39 (0.37-0.41)	0.27 (0.25-0.28)	0.32 (0.31-0.34)	0.18 (0.17-0.20)	0.05 (0.04-0.05)	1.04 (1.01-1.08)	2,819.5	0.67 (0.64-0.70)
Uncemented and															
MoP	1,277.1	3.99 (3.88-4.10)	0.95 (0.90-1.01)	0.36 (0.33-0.39)	0.92 (0.87-0.97)	0.61 (0.57-0.66)	0.86 (0.81-0.91)	0.35 (0.32-0.38)	0.21 (0.19-0.24)	0.41 (0.37-0.44)	0.09 (0.08-0.11)	0.04 (0.03-0.05)	0.19 (0.17-0.22)	1,059.6	0.19 (0.17-0.22)
MoM	319.4	17.66 (17.20-18.13)	3.40 (3.20-3.61)	3.24 (3.05-3.44)	0.79 (0.69-0.89)	1.40 (1.27-1.53)	0.87 (0.77-0.98)	0.71 (0.63-0.81)	1.38 (1.25-1.51)	0.60 (0.52-0.69)	0.18 (0.14-0.23)	0.08 (0.05-0.12)	9.76 (9.43-10.11)	160.1	9.32 (8.86-9.81)
CoP	721.1	3.32 (3.19-3.46)	0.82 (0.75-0.89)	0.27 (0.24-0.31)	0.84 (0.78-0.91)	0.60 (0.55-0.66)	0.49 (0.44-0.54)	0.33 (0.29-0.37)	0.12 (0.09-0.14)	0.26 (0.23-0.31)	0.08 (0.07-0.11)	0.03 (0.02-0.05)	0.06 (0.05-0.08)	602.9	0.05 (0.04-0.08)
CoC	1,116.6	3.68 (3.57-3.80)	1.13 (1.07-1.19)	0.49 (0.45-0.53)	0.49 (0.45-0.54)	0.50 (0.46-0.55)	0.51 (0.47-0.56)	0.38 (0.34-0.41)	0.10 (0.08-0.12)	0.19 (0.16-0.21)	0.35 (0.32-0.39)	0.04 (0.03-0.06)	0.13 (0.11-0.15)	969.9	0.12 (0.10-0.15)
CoM	22.3	8.64 (7.50-9.95)	3.04 (2.40-3.86)	1.34 (0.94-1.92)	0.54 (0.31-0.95)	0.98 (0.65-1.50)	0.63 (0.37-1.06)	0.63 (0.37-1.06)	0.63 (0.37-1.06)	0.49 (0.27-0.89)	0.18 (0.07-0.48)	0.18 (0.07-0.48)	2.24 (1.70-2.95)	21.6	2.17 (1.63-2.89)
MoPoM	3.3	9.18 (6.42-13.13)	1.84 (0.82-4.09)	0.61 (0.15-2.45)	1.53 (0.64-3.68)	2.75 (1.43-5.29)	2.45 (1.22-4.89)	0.61 (0.15-2.45)	0.00 (.-.)	0.31 (0.04-2.17)	0.00 (.-.)	0.00 (.-.)	0.61 (0.15-2.45)	3.2	0.62 (0.16-2.48)
CoPoM	1.4	5.56 (2.78-11.12)	0.70 (0.10-4.94)	0.70 (0.10-4.94)	0.00 (.-.)	2.09 (0.67-6.47)	1.39 (0.35-5.56)	1.39 (0.35-5.56)	0.00 (.-.)	1.39 (0.35-5.56)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	1.4	0.00 (.-.)
Others	0.9	16.50 (9.95-27.38)	1.10 (0.15-7.81)	1.10 (0.15-7.81)	2.20 (0.55-8.80)	2.20 (0.55-8.80)	2.20 (0.55-8.80)	2.20 (0.55-8.80)	2.20 (0.55-8.80)	0.00 (.-.)	1.10 (0.15-7.81)	2.20 (0.55-8.80)	7.70 (3.67-16.16)	0.7	8.11 (3.64-18.06)

*Including 38,760 with unconfirmed fixation/bearing.
**Rates are likely to be underestimated: this reason was not solicited in the early phase of the registry (revision report forms MDSv1/MDSv2).
***For primaries from 2008 onwards the majority of revision report forms were MDSv3/MDSv6 which explicitly gave this indication for revision as an option.

Table 3.H9 (continued)

Fixation and bearing surface	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Aseptic loosening	Pain	Dislocation/ Subluxation	Infection	Periprosthetic fracture	Malalignment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Adverse reaction to particulate debris**	Adverse reaction to particulate debris for primaries from 1.1.2008***: Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years
All hybrid	**1,784.5**	**3.53 (3.44-3.62)**	**0.49 (0.45-0.52)**	**0.25 (0.23-0.27)**	**0.88 (0.84-0.92)**	**0.77 (0.73-0.81)**	**0.86 (0.82-0.91)**	**0.22 (0.20-0.24)**	**0.16 (0.14-0.18)**	**0.19 (0.17-0.21)**	**0.15 (0.13-0.17)**	**0.02 (0.01-0.03)**	**0.18 (0.16-0.20)**	**1,437.2**	**0.11 (0.09-0.12)**
Hybrid and															
MoP	1,040.7	3.47 (3.36-3.59)	0.51 (0.47-0.56)	0.21 (0.18-0.24)	0.96 (0.91-1.03)	0.74 (0.69-0.80)	0.96 (0.90-1.02)	0.23 (0.20-0.26)	0.17 (0.15-0.20)	0.21 (0.19-0.24)	0.09 (0.08-0.11)	0.02 (0.01-0.03)	0.07 (0.05-0.08)	818.7	0.06 (0.04-0.08)
MoM	27.4	15.43 (14.03-16.98)	2.88 (2.31-3.59)	2.66 (2.12-3.35)	1.17 (0.83-1.65)	1.13 (0.80-1.61)	1.75 (1.32-2.32)	0.44 (0.25-0.77)	1.61 (1.19-2.16)	0.33 (0.17-0.63)	0.36 (0.20-0.68)	0.07 (0.02-0.29)	7.30 (6.35-8.38)	10.4	6.17 (4.83-7.89)
CoP	448.8	3.26 (3.09-3.43)	0.27 (0.22-0.32)	0.14 (0.11-0.17)	0.92 (0.84-1.02)	0.95 (0.87-1.05)	0.74 (0.66-0.82)	0.17 (0.14-0.21)	0.08 (0.06-0.11)	0.14 (0.11-0.17)	0.11 (0.08-0.15)	0.02 (0.01-0.04)	0.03 (0.02-0.06)	416.0	0.03 (0.02-0.05)
CoC	251.5	2.84 (2.64-3.06)	0.51 (0.43-0.61)	0.39 (0.32-0.47)	0.39 (0.32-0.47)	0.47 (0.39-0.56)	0.54 (0.46-0.64)	0.26 (0.21-0.33)	0.11 (0.08-0.16)	0.14 (0.10-0.19)	0.41 (0.33-0.49)	0.02 (0.01-0.05)	0.13 (0.09-0.18)	176.2	0.14 (0.10-0.21)
MoPoM	12.2	5.15 (4.02-6.59)	0.57 (0.27-1.20)	0.00 (.-.)	1.06 (0.62-1.83)	1.72 (1.12-2.63)	1.47 (0.93-2.34)	0.08 (0.01-0.58)	0.08 (0.01-0.58)	0.49 (0.22-1.09)	0.08 (0.01-0.58)	0.00 (.-.)	0.08 (0.01-0.58)	12.2	0.08 (0.01-0.58)
CoPoM	2.9	5.18 (3.12-8.59)	0.69 (0.17-2.76)	0.00 (.-.)	1.73 (0.72-4.15)	1.38 (0.52-3.68)	2.07 (0.93-4.61)	0.35 (0.05-2.45)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.35 (0.05-2.45)	0.00 (.-.)	2.9	0.00 (.-.)
Others	1.0	6.07 (2.73-13.51)	1.01 (0.14-7.18)	0.00 (.-.)	2.02 (0.51-8.09)	1.01 (0.14-7.18)	1.01 (0.14-7.18)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	2.02 (0.51-8.09)	0.00 (.-.)	1.01 (0.14-7.18)	0.8	1.24 (0.18-8.83)
All reverse hybrid	**220.8**	**3.75 (3.50-4.01)**	**1.21 (1.07-1.36)**	**0.28 (0.22-0.36)**	**0.80 (0.69-0.92)**	**0.69 (0.59-0.81)**	**0.66 (0.56-0.77)**	**0.27 (0.21-0.35)**	**0.20 (0.15-0.27)**	**0.23 (0.17-0.30)**	**0.05 (0.03-0.10)**	**0.02 (0.01-0.05)**	**0.10 (0.06-0.15)**	**194.9**	**0.06 (0.03-0.11)**
Reverse hybrid and															
MoP	146.6	3.78 (3.48-4.11)	1.18 (1.02-1.37)	0.19 (0.13-0.28)	0.87 (0.73-1.04)	0.68 (0.56-0.83)	0.76 (0.63-0.91)	0.25 (0.18-0.34)	0.22 (0.15-0.31)	0.21 (0.15-0.30)	0.05 (0.02-0.10)	0.01 (0.00-0.05)	0.08 (0.04-0.14)	129.7	0.06 (0.03-0.12)
CoP	73.0	3.45 (3.05-3.91)	1.25 (1.02-1.53)	0.44 (0.31-0.62)	0.63 (0.47-0.84)	0.71 (0.54-0.93)	0.45 (0.32-0.64)	0.29 (0.19-0.44)	0.15 (0.08-0.27)	0.26 (0.17-0.41)	0.05 (0.02-0.15)	0.03 (0.01-0.11)	0.03 (0.01-0.11)	64.4	0.02 (0.00-0.11)
Others	1.2	16.63 (10.73-25.78)	2.50 (0.80-7.74)	1.66 (0.42-6.65)	1.66 (0.42-6.65)	0.83 (0.12-5.90)	0.83 (0.12-5.90)	2.50 (0.80-7.74)	0.83 (0.12-5.90)	0.00 (.-.)	0.83 (0.12-5.90)	0.00 (.-.)	6.65 (3.33-13.30)	0.8	3.58 (1.15-11.09)
All resurfacing	**477.6**	**9.89 (9.61-10.18)**	**2.12 (1.99-2.25)**	**2.83 (2.69-2.99)**	**0.23 (0.19-0.28)**	**0.45 (0.39-0.51)**	**1.06 (0.98-1.16)**	**0.54 (0.48-0.61)**	**0.87 (0.79-0.95)**	**0.24 (0.20-0.28)**	**0.21 (0.18-0.26)**	**0.05 (0.04-0.08)**	**3.59 (3.43-3.77)**	**201.7**	**2.90 (2.67-3.14)**
Resurfacing and															
MoM	476.9	9.89 (9.61-10.18)	2.12 (1.99-2.25)	2.84 (2.69-2.99)	0.23 (0.19-0.28)	0.45 (0.39-0.52)	1.06 (0.97-1.16)	0.54 (0.48-0.61)	0.87 (0.79-0.96)	0.23 (0.20-0.28)	0.21 (0.18-0.26)	0.05 (0.04-0.08)	3.60 (3.43-3.77)	201.0	2.91 (2.68-3.15)
Others	0.7	8.49 (3.81-18.89)	2.83 (0.71-11.31)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	4.24 (1.37-13.16)	0.00 (.-.)	0.00 (.-.)	1.41 (0.20-10.04)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.7	0.00 (.-.)

*Including 38,760 with unconfirmed fixation/bearing.
**Rates are likely to be underestimated: this reason was not solicited in the early phase of the registry (revision report forms MDSv1/MDSv2).
***For primaries from 2008 onwards the majority of revision report forms were MDSv3/MDSv6 which explicitly gave this indication for revision as an option.

Table 3.H10 PTIR estimates of indications for hip revision (95% CI) by years following primary hip replacement.

Time since primary	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for:												Adverse reaction to particulate debris for primaries from 1.1.2008***	
		All causes	Aseptic loosening	Pain	Dislocation/ Subluxation	Infection	Peripros-thetic fracture	Malalign-ment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Adverse reaction to particulate debris**	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years
All cases	9,223.7	4.38 (4.34-4.42)	1.08 (1.06-1.10)	0.54 (0.53-0.56)	0.76 (0.74-0.78)	0.67 (0.65-0.68)	0.69 (0.67-0.71)	0.29 (0.28-0.30)	0.26 (0.25-0.27)	0.25 (0.24-0.26)	0.14 (0.13-0.15)	0.03 (0.03-0.03)	0.65 (0.63-0.67)	6,835.2	0.41 (0.39-0.42)
<1 year	1,281.4	8.24 (8.08-8.40)	0.97 (0.91-1.02)	0.47 (0.44-0.51)	2.46 (2.38-2.55)	2.03 (1.96-2.11)	1.69 (1.62-1.76)	0.69 (0.65-0.74)	0.07 (0.05-0.08)	0.30 (0.27-0.33)	0.20 (0.18-0.22)	0.10 (0.08-0.12)	0.08 (0.07-0.10)	1,087.7	0.10 (0.08-0.12)
1 to <3 years	2,286.3	3.32 (3.25-3.40)	0.89 (0.85-0.93)	0.62 (0.58-0.65)	0.59 (0.56-0.62)	0.66 (0.63-0.70)	0.38 (0.35-0.40)	0.29 (0.27-0.32)	0.12 (0.11-0.14)	0.12 (0.10-0.13)	0.11 (0.09-0.12)	0.03 (0.02-0.03)	0.19 (0.17-0.21)	1,910.6	0.21 (0.19-0.23)
3 to <5 years	1,835.1	3.21 (3.12-3.29)	0.83 (0.79-0.87)	0.64 (0.61-0.68)	0.43 (0.40-0.46)	0.41 (0.38-0.44)	0.43 (0.40-0.46)	0.21 (0.19-0.23)	0.18 (0.16-0.20)	0.16 (0.14-0.18)	0.10 (0.09-0.12)	0.01 (0.01-0.02)	0.59 (0.55-0.62)	1,478.4	0.46 (0.42-0.49)
5 to <7 years	1,394.1	3.71 (3.62-3.82)	0.99 (0.94-1.04)	0.65 (0.61-0.69)	0.39 (0.36-0.43)	0.33 (0.30-0.36)	0.53 (0.49-0.57)	0.21 (0.18-0.23)	0.27 (0.24-0.30)	0.21 (0.19-0.23)	0.13 (0.11-0.15)	0.01 (0.01-0.02)	1.03 (0.98-1.09)	1,061.0	0.60 (0.55-0.65)
7 to <10 years	1,382.7	4.22 (4.12-4.33)	1.30 (1.24-1.36)	0.47 (0.43-0.51)	0.47 (0.44-0.51)	0.33 (0.30-0.36)	0.62 (0.58-0.67)	0.20 (0.17-0.22)	0.43 (0.40-0.47)	0.29 (0.26-0.32)	0.15 (0.14-0.18)	0.01 (0.01-0.02)	1.18 (1.13-1.24)	934.4	0.69 (0.64-0.75)
10 to <13 years	724.8	5.07 (4.91-5.24)	1.82 (1.73-1.92)	0.29 (0.25-0.33)	0.52 (0.47-0.57)	0.37 (0.33-0.42)	0.89 (0.82-0.96)	0.17 (0.14-0.20)	0.67 (0.61-0.73)	0.54 (0.49-0.60)	0.20 (0.17-0.24)	0.02 (0.01-0.03)	1.30 (1.22-1.38)	343.5	0.88 (0.79-0.99)
13 to <15 years	219.7	5.32 (5.02-5.63)	2.12 (1.94-2.32)	0.24 (0.18-0.32)	0.54 (0.45-0.64)	0.36 (0.28-0.44)	0.86 (0.75-0.99)	0.16 (0.11-0.22)	0.89 (0.77-1.02)	0.80 (0.69-0.93)	0.24 (0.18-0.32)	0.01 (0.00-0.04)	1.27 (1.13-1.43)	19.6	1.17 (0.78-1.76)
15 to <17 years	85.0	4.77 (4.32-5.25)	2.09 (1.81-2.43)	0.15 (0.09-0.26)	0.54 (0.41-0.72)	0.27 (0.18-0.41)	1.01 (0.82-1.25)	0.20 (0.12-0.32)	0.88 (0.70-1.11)	0.85 (0.67-1.07)	0.22 (0.14-0.35)	0.02 (0.01-0.09)	0.76 (0.60-0.98)		
≥17 years*	14.6	5.48 (4.40-6.83)	3.15 (2.36-4.21)	0.07 (0.01-0.49)	0.48 (0.23-1.01)	0.27 (0.10-0.73)	1.10 (0.67-1.79)	0.14 (0.03-0.55)	1.23 (0.78-1.96)	0.89 (0.52-1.53)	0.27 (0.10-0.73)	0.00 (.-.)	0.55 (0.27-1.10)		

*Current maximum observed follow up is 18.75 years.
**Rates are likely to be underestimated: this reason was not solicited in the early phase of the registry (revision report forms MDSv1/MDSv2).
***For primaries from 2008 onwards the majority of revision report forms were MDSv3/MDSv6 which explicitly gave this indication for revision as an option.
Note: Blank cells indicate there are no current data.

In Table 3.H10 (page 101), the PTIRs for each indication are shown separately for different time periods from the primary hip replacement, within the first year, and between 1 to <3, 3 to <5, 5 to <7, 7 to <10, 10 to <13, 13 to <15, 15 to <17, and ≥17 years after surgery (the maximum follow-up for any implant is now 18.75 years). Revision rates due to aseptic loosening are fairly constant until five years and then begin to steadily increase. Revision due to pain rises out to seven years and then declines. The rates due to subluxation / dislocation, infection and malalignment were all higher in the first year and then fell. In the case of periprosthetic fracture, the highest rates were seen in the first year, these then declined markedly before beginning to rise again at around seven years. Adverse reaction to particulate debris increased until 15 years before declining, whereas lysis continued to rise with time.

Figures 3.H11 (a) to 3.H11 (g) (pages 103 to 106) show how PTIRs for aseptic loosening, pain, dislocation / subluxation, infection, lysis and adverse soft tissue reaction to particulate debris changed with time. Only sub-groups with a total overall prosthesis-years at risk of more than 150,000 have been included. With time from the operation, PTIRs for aseptic loosening tended to rise in cemented fixations and follow a fairly similar pattern in uncemented metal-on-polyethylene bearings. In uncemented metal-on-metal, they rose and then fell. In uncemented ceramic-on-polyethylene, ceramic-on-ceramic, hybrid ceramic-on-ceramic and resurfacings, the PTIRs were reasonably consistent over time. In hybrid metal-on-polyethylene and ceramic-on-polyethylene bearings, there were marked increases at later time points. For pain, PTIRs were either fairly consistent or had a small initial peak followed by a decline to fairly constant rates for all bearings, apart from uncemented metal-on-metal and resurfacings where rates started high, rose to peaks at five years and then declined again. Conversely, there was a high initial rate for dislocation / subluxation in all fixation / bearing groups which later fell but then began to rise again in all groups apart from cemented metal-on-polyethylene, uncemented metal-on-metal, hybrid ceramic-on-ceramic and resurfacing (Figure 3.H11 (c), page 104). Revision rates for infection were initially high and then fell in all groups apart from uncemented metal-on-metal primary total hip replacement and resurfacing (Figure 3.H11 (d), page 104). The opposite was seen for lysis with increasing rates over time in all groups (Figure 3.H11 (e), page 105).

Revision rates due to an adverse reaction to particulate debris increased with time, up to seven years in uncemented metal-on-metal primary total hip replacement and resurfacings (Figures 3.H11 (f) and (g), pages 105 and 106). Confidence intervals have not been shown here for simplicity but could be quite wide.

Figure 3.H11 (a) PTIR estimates of aseptic loosening by fixation and bearing.

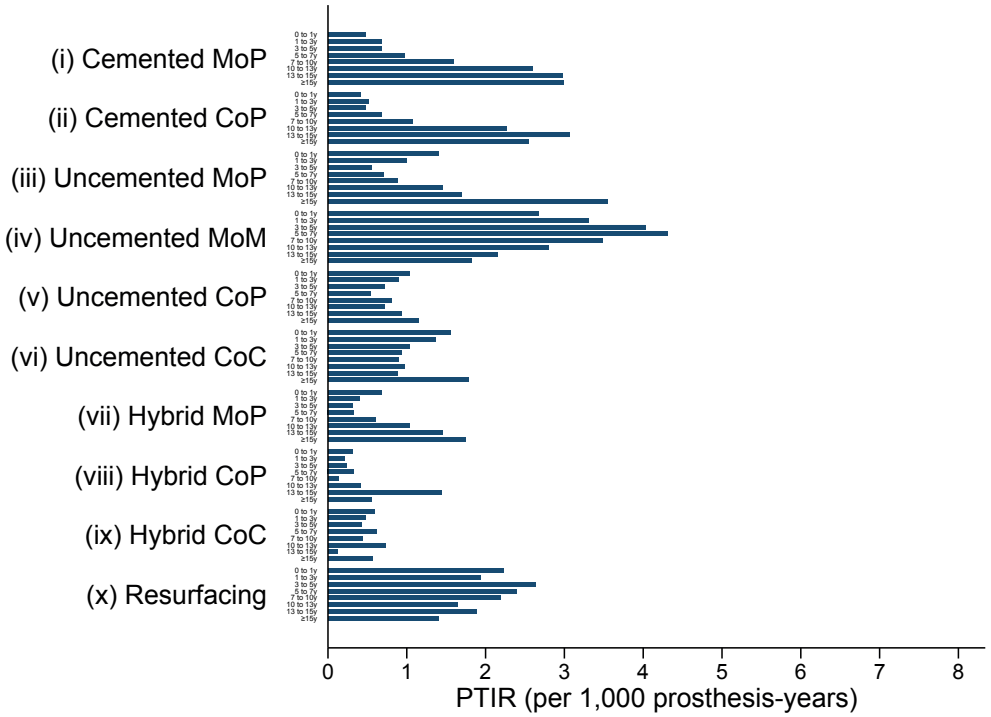


Figure 3.H11 (b) PTIR estimates of pain by fixation and bearing.

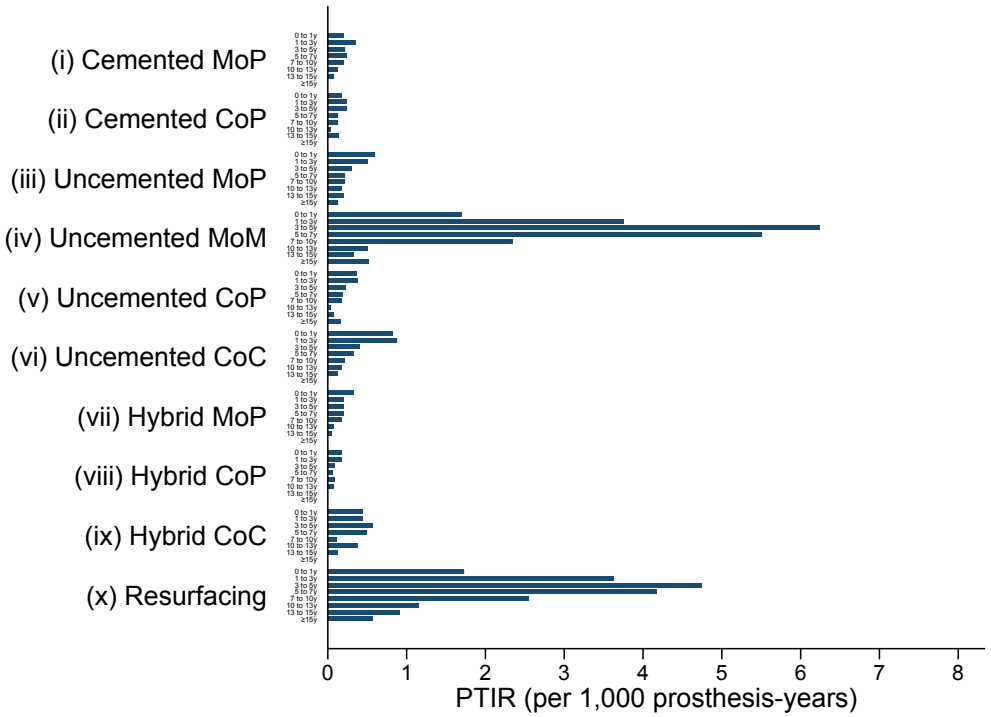


Figure 3.H11 (c) PTIR estimates of dislocation / subluxation by fixation and bearing.

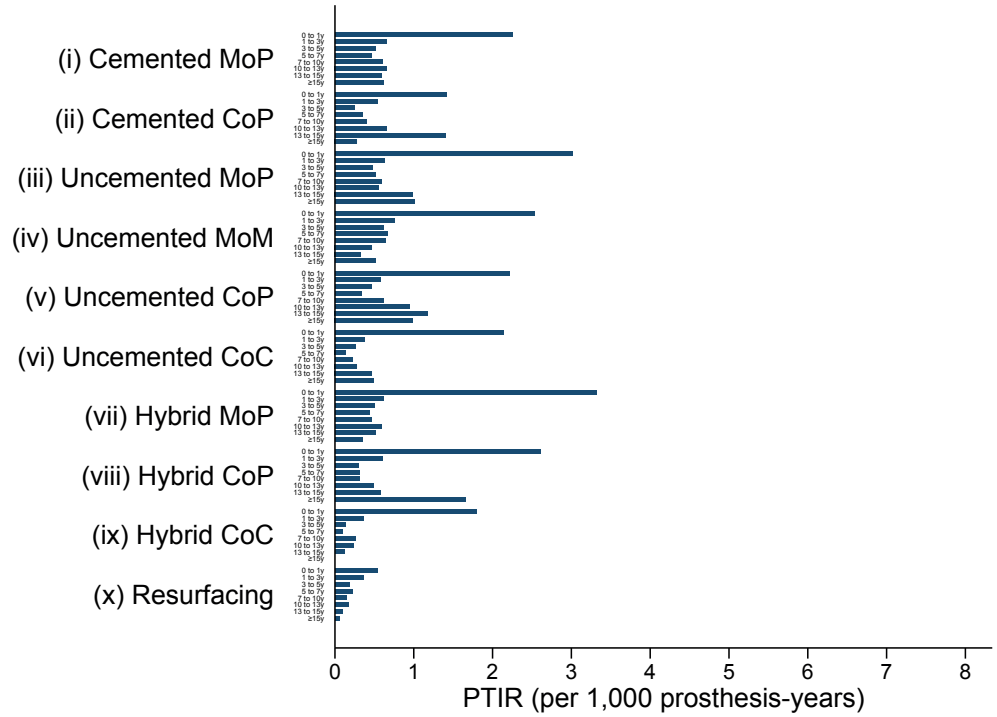


Figure 3.H11 (d) PTIR estimates of infection by fixation and bearing.

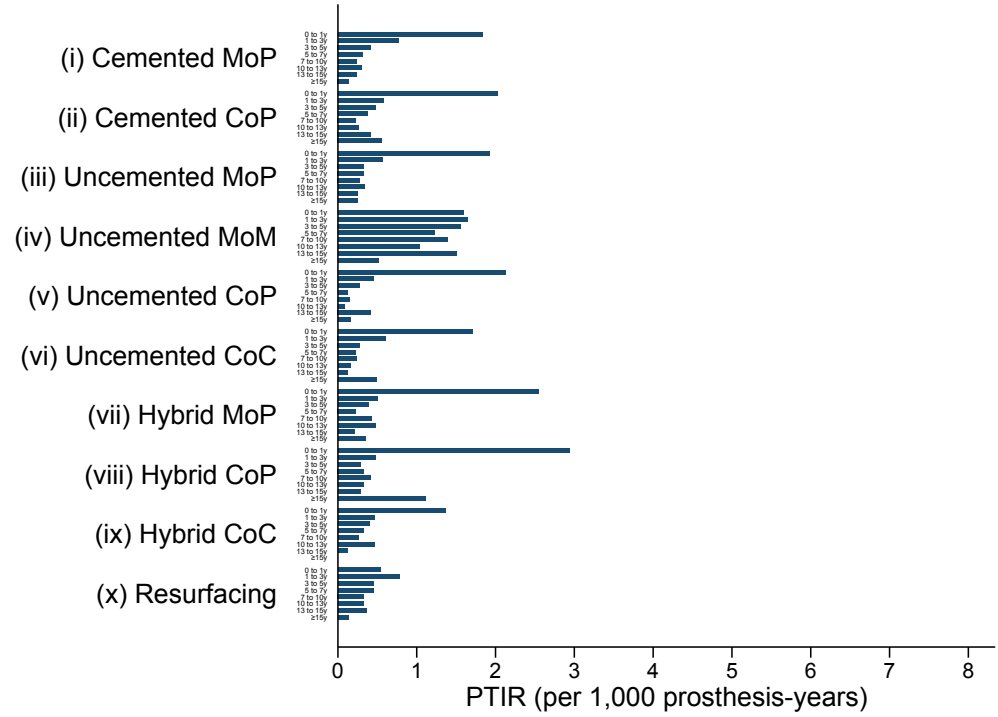


Figure 3.H11 (e) PTIR estimates of lysis by fixation and bearing.

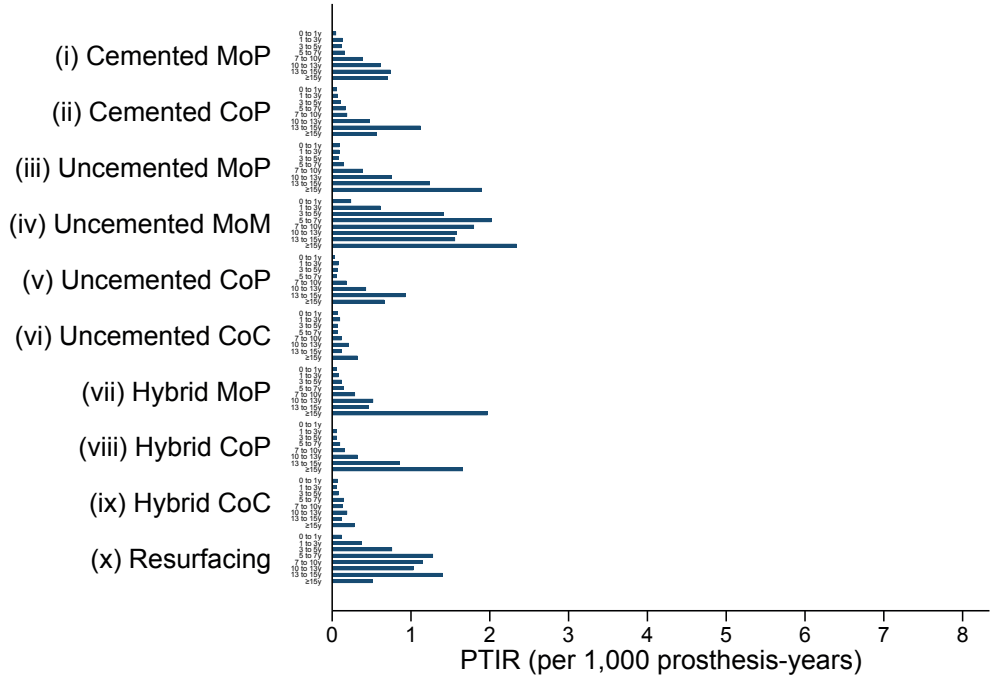


Figure 3.H11 (f) PTIR estimates of adverse soft tissue reaction by fixation and bearing.

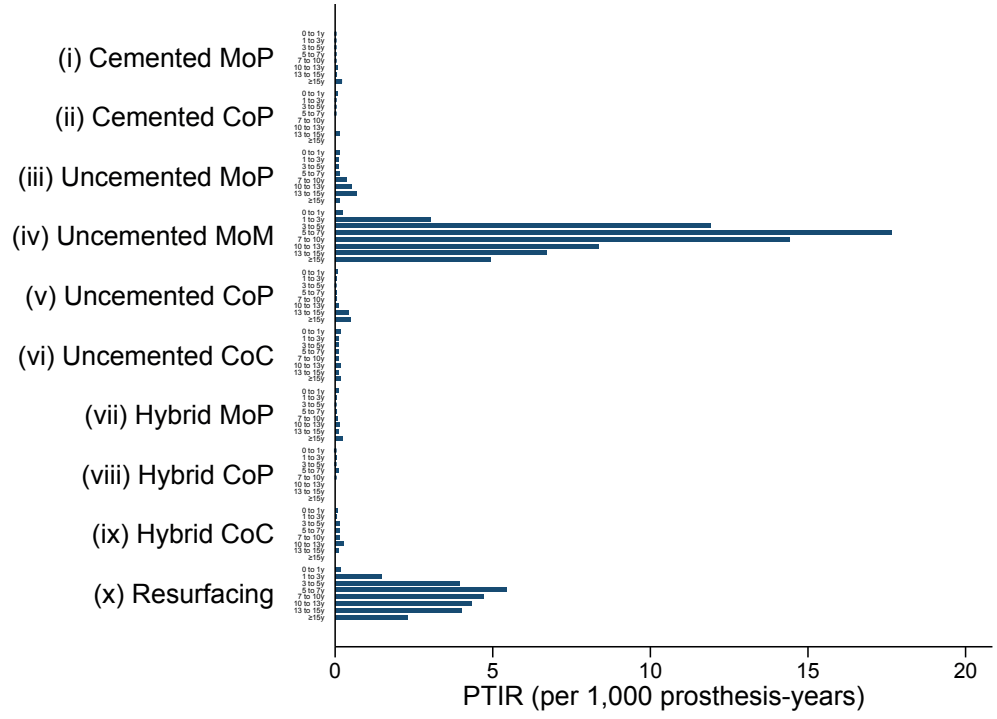
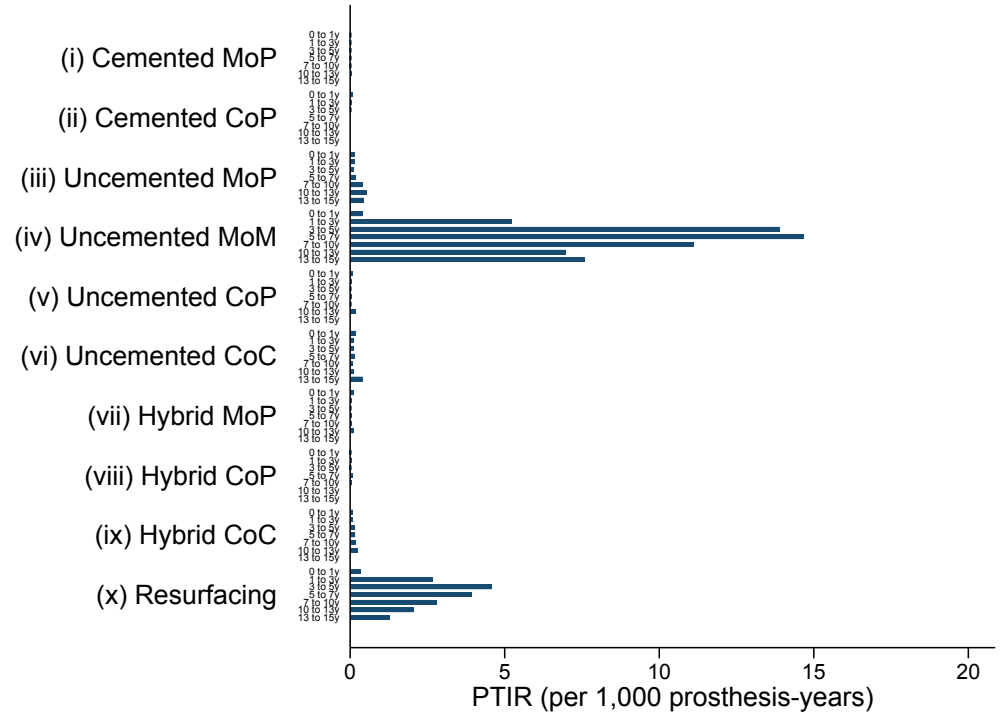


Figure 3.H11 (g) PTIR estimates of adverse soft tissue reaction by fixation and bearing, since 2008.



3.2.6 Mortality after primary hip replacement surgery

In this section we describe the mortality of the cohort up to 18 years from primary hip replacement, according to gender and age group. Deaths recorded after 31 December 2021 were not included in the analysis. For simplicity, we have not taken into account whether the patient had a first (or further) joint revision after the primary operation when calculating the cumulative probability of death. While such surgery may have contributed to the overall mortality, the impact of this is not investigated in this report (see survival analysis methods note in section 3.1). Among the 1,344,357 primary hip replacements, there were 5,790 bilateral operations, with the left and right side operated on the same day; here the second of the two has been excluded, leaving 1,338,567 primary hip replacements, of whom 275,912 had died before the end of 2021.

Table 3.H11 KM estimates of cumulative mortality (95% CI) by age and gender, in primary hip replacement. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

		Time since primary						
Age group	N	30 days	90 days	1 year	5 years	10 years	15 years	18 years
All cases	1,338,567*	0.21 (0.20-0.22)	0.46 (0.45-0.47)	1.45 (1.43-1.47)	9.61 (9.56-9.67)	25.58 (25.48-25.68)	44.09 (43.92-44.25)	54.77 (54.46-55.07)
Male								
<55 years	79,063	0.07 (0.05-0.09)	0.16 (0.13-0.19)	0.52 (0.47-0.57)	2.30 (2.19-2.42)	5.39 (5.19-5.60)	9.67 (9.31-10.05)	13.59 (12.81-14.42)
55 to 59 years	55,154	0.06 (0.04-0.08)	0.20 (0.17-0.24)	0.64 (0.57-0.71)	3.42 (3.26-3.59)	8.88 (8.57-9.20)	17.05 (16.47-17.64)	24.10 (22.89-25.37)
60 to 64 years	76,549	0.11 (0.09-0.13)	0.24 (0.21-0.28)	0.82 (0.76-0.89)	4.73 (4.57-4.90)	12.32 (12.02-12.62)	24.72 (24.14-25.31)	35.46 (34.21-36.74)
65 to 69 years	90,357	0.15 (0.13-0.18)	0.36 (0.32-0.40)	1.10 (1.04-1.17)	6.86 (6.69-7.05)	18.89 (18.55-19.24)	38.60 (37.96-39.25)	52.63 (51.39-53.88)
70 to 74 years	94,024	0.20 (0.17-0.23)	0.44 (0.40-0.48)	1.59 (1.51-1.68)	10.49 (10.27-10.71)	29.41 (29.01-29.81)	56.88 (56.22-57.55)	72.76 (71.52-73.98)
75 to 79 years	76,597	0.38 (0.33-0.42)	0.75 (0.69-0.81)	2.50 (2.39-2.61)	16.77 (16.48-17.07)	46.48 (45.98-46.97)	78.04 (77.36-78.73)	*89.97 (88.85-91.01)*
80 to 84 years	45,427	0.69 (0.62-0.77)	1.37 (1.27-1.48)	3.98 (3.80-4.17)	26.73 (26.27-27.19)	66.98 (66.33-67.64)	92.19 (91.54-92.81)	*97.13 (96.25-97.85)*
≥85 years	19,922	1.58 (1.41-1.76)	2.86 (2.64-3.10)	7.55 (7.19-7.94)	43.51 (42.71-44.31)	85.96 (85.19-86.71)	*98.17 (97.61-98.62)*	*99.10 (98.49-99.49)*
Female								
<55 years	79,950	0.06 (0.05-0.08)	0.20 (0.18-0.24)	0.65 (0.59-0.71)	2.51 (2.39-2.63)	5.20 (5.01-5.40)	8.81 (8.46-9.17)	11.66 (10.98-12.37)
55 to 59 years	63,586	0.06 (0.05-0.09)	0.18 (0.15-0.22)	0.59 (0.53-0.65)	3.03 (2.88-3.18)	7.20 (6.94-7.46)	13.26 (12.79-13.74)	19.33 (18.29-20.41)
60 to 64 years	96,129	0.07 (0.05-0.09)	0.18 (0.15-0.21)	0.61 (0.56-0.66)	3.70 (3.57-3.83)	9.40 (9.16-9.64)	18.96 (18.49-19.44)	26.37 (25.41-27.36)
65 to 69 years	131,943	0.08 (0.07-0.10)	0.21 (0.19-0.24)	0.74 (0.69-0.79)	4.87 (4.74-5.00)	13.82 (13.57-14.07)	29.24 (28.75-29.75)	41.88 (40.86-42.91)
70 to 74 years	153,880	0.11 (0.09-0.13)	0.26 (0.24-0.29)	0.94 (0.89-0.99)	7.04 (6.90-7.19)	21.70 (21.41-21.99)	45.31 (44.78-45.84)	62.75 (61.67-63.83)
75 to 79 years	136,708	0.21 (0.18-0.23)	0.43 (0.40-0.47)	1.46 (1.40-1.52)	11.41 (11.22-11.60)	34.65 (34.30-35.01)	66.31 (65.75-66.86)	*83.10 (82.12-84.06)*
80 to 84 years	91,914	0.33 (0.30-0.37)	0.76 (0.71-0.82)	2.45 (2.35-2.55)	18.47 (18.19-18.75)	53.82 (53.35-54.28)	85.56 (85.03-86.09)	*95.28 (94.53-95.96)*
≥85 years	47,364	0.79 (0.71-0.87)	1.72 (1.60-1.84)	4.72 (4.53-4.92)	32.18 (31.70-32.65)	75.29 (74.72-75.86)	*95.79 (95.34-96.22)*	*98.47 (97.88-98.92)*

*Some patients had operations on the left and right side on the same day. The second of 5,790 pairs of simultaneous bilateral operations were excluded.

Table 3.H11 (page 107) shows Kaplan-Meier estimates of cumulative percentage mortality at 30 days, 90 days and at 1, 5, 10, 15 and 18 years from the primary hip replacement, for all cases and by age and gender. It is clear that younger patients had a lower risk of death. These differences were apparent at 30 days, with approximately half the risk of death for a male patient under the age of 55 compared to one aged 65 to 69 years. These differences persisted to one year and then diverged further with almost four times the risk of death in the older group at 18 years. For a similar age group comparison, there was little initial difference for females but by 18 years, there was over three and half times the risk of death in the older group. It is worthy of note that for all cases in the registry, there is almost a 10% risk of death by five years, over 25% by ten years, over 40% by 15 years and over 50% by 18 years after primary hip replacement.

3.2.7 Primary hip replacement for fractured neck of femur compared with other reasons for implantation

Total hip replacement is an increasingly utilised treatment option for fractured neck of femur and in this section, we report on revision and mortality rates for primary total hip replacements performed because of a fractured neck of femur compared to cases performed for other indications. A total of 50,008 (3.7%) of the primary total hip replacements were performed for a fractured neck of femur (NOF)†.

Table 3.H12 (page 109) shows that the proportion of primary hip replacements performed for an indication of a fractured neck of femur has continued to increase with time to a maximum of 7.3% in 2020. The use of dual mobility bearings has become more popular in this group and accounted for 8.4% of cases in 2020. The most striking feature is the marked drop in 2020 in the total annual number of THRs performed for a fractured NOF (4,119 compared to 5,648 in 2019). This was likely due to the impact of the COVID-19 pandemic, but how much is due to fewer fractures occurring during lockdown and how much is due to less provision of care because of the impact on services by the pandemic is not discernible from these figures. This has been sustained in 2021 with only 4,147 THRs performed for fractured neck of femur. There are usually late registrations of cases into the registry and thus the figures for 2021 may be revised upwards in next year's report, but this observation may also be related to the publication of the HEALTH trial which demonstrated no difference in the risk of secondary procedures for patients receiving total hip replacement or hemiarthroplasty for a displaced hip fracture and a clinically unimportant improvement in function and quality of life for patients receiving a total hip replacement (Bhandari M, et al., 2019).

†These comprised 2,252 cases with the indication for primary hip replacement including fractured neck of femur in the early phase of the registry (i.e. 205,032 implants entered using MDSv1 and v2) and 47,756 cases with indications including acute trauma neck of femur in the later phase (i.e. 1,139,325 entered using MDSv3, v6 and v7).

Bhandari M et al.; Total Hip Arthroplasty or Hemiarthroplasty for Hip Fracture. Value Health. N Engl J Med 2019; 381:2199-2208.

Table 3.H12 Number and percentage fractured neck of femur in the registry by year.

Year of primary	N (Primary total hip replacements for all indications)	N (NOF) (%)	NOF treated with	
			Dual mobility, N(%)	Unipolar, N(%)
2003	14,977	143 (1.0)	0 (0.0)	143 (100.0)
2004	29,283	298 (1.0)	0 (0.0)	298 (100.0)
2005	41,698	395 (0.9)	0 (0.0)	395 (100.0)
2006	48,561	529 (1.1)	0 (0.0)	529 (100.0)
2007	61,729	787 (1.3)	0 (0.0)	787 (100.0)
2008	67,715	868 (1.3)	<4 (0.1)	867 (99.9)
2009	68,663	1,082 (1.6)	11 (1.0)	1,071 (99.0)
2010	71,181	1,371 (1.9)	8 (0.6)	1,363 (99.4)
2011	74,136	1,724 (2.3)	19 (1.1)	1,705 (98.9)
2012	78,351	2,441 (3.1)	21 (0.9)	2,420 (99.1)
2013	80,485	3,118 (3.9)	76 (2.4)	3,042 (97.6)
2014	87,732	3,723 (4.2)	149 (4.0)	3,574 (96.0)
2015	89,908	4,207 (4.7)	186 (4.4)	4,021 (95.6)
2016	94,405	4,871 (5.2)	295 (6.1)	4,576 (93.9)
2017	96,503	5,014 (5.2)	311 (6.2)	4,703 (93.8)
2018	97,563	5,523 (5.7)	343 (6.2)	5,180 (93.8)
2019	99,873	5,648 (5.7)	451 (8.0)	5,197 (92.0)
2020	56,596	4,119 (7.3)	353 (8.6)	3,766 (91.4)
2021	84,998	4,147 (4.9)	390 (9.4)	3,757 (90.6)
Total	1,344,357	50,008 (3.7)	2,614 (5.2)	47,394 (94.8)

Table 3.H13 Fractured neck of femur versus osteoarthritis only by gender, age and fixation.

	Reason for primary hip replacement		Comparison
	Fractured neck of femur (n=50,008)	Osteoarthritis only (n=1,183,460)	
% Female	72.2%	59.2%	P<0.001 (Chi-squared test)
Median age (IQR)			
Both genders	73 (66 to 79)	70 (62 to 76)	P<0.001 (Mann-Whitney U-test)
Male only	72 (65 to 79)	68 (60 to 75)	P<0.001 (Mann-Whitney U-test)
Female only	73 (66 to 79)	71 (63 to 77)	P<0.001 (Mann-Whitney U-test)
% Hip type*			
All cemented	42.0	31.6	Overall P<0.001 (Chi-squared test)
All uncemented	19.0	38.8	
All hybrid	36.8	23.6	
All reverse hybrid	2.1	2.7	
All resurfacing	<0.1	3.3	

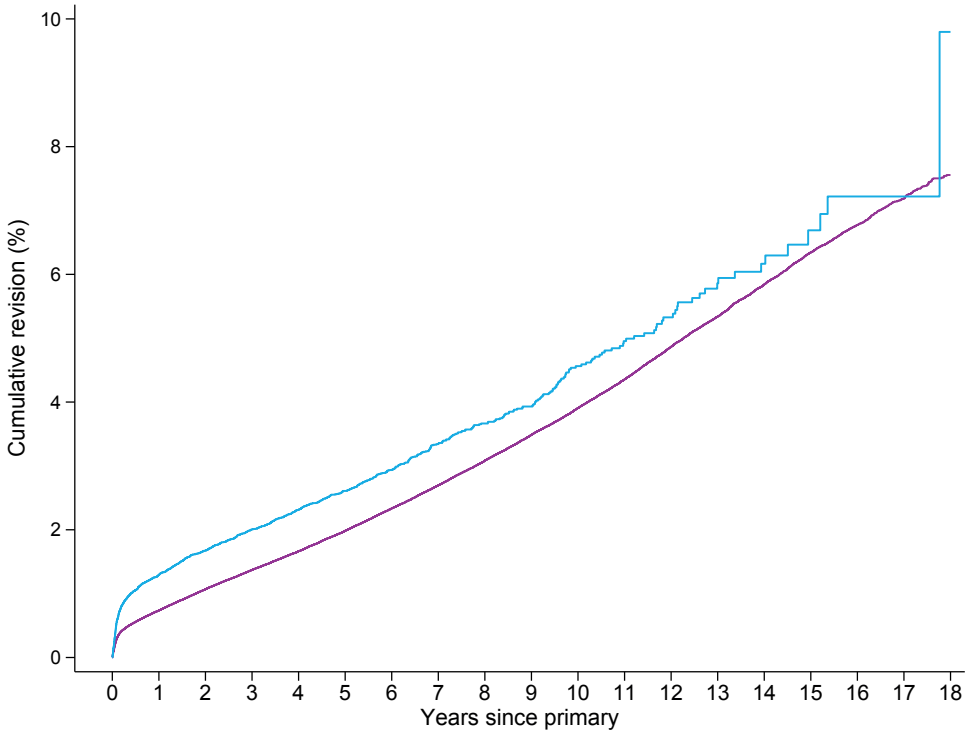
*Excludes 110,889 cases who had other reasons in addition to osteoarthritis.

Table 3.H13 compares the fractured NOF group with the remainder with respect to gender and age composition together and type of hip replacement received. A significantly larger percentage of the fractured NOF cases, compared with the remainder, were female (72.2% versus 59.2%: P<0.001, Chi-squared test).

The fractured NOF cases were significantly older (median age 73 years versus 70 years at operation: P<0.001 by Mann-Whitney U-test). We found that cemented and hybrid hips were used more commonly in fractured NOF cases than in hip replacements performed for osteoarthritis only, but cemented fixation was still used in under half of the patients. Figure 3.H12 (a) (page 111) shows that the cumulative revision rate was higher in the fractured NOF cases group compared with the remainder (P<0.001, logrank test). This effect was not fully explained by differences in age and gender, as stratification by these variables left the result unchanged (P<0.001 using stratified logrank test: 14 sub-groups of age <55, 55 to 59, 60 to 64, 65 to 69, 70 to 74, 75 to 79, ≥80 for each gender). Figure 3.H12 (b) (page 112) shows similar cumulative revision rates for dual mobility compared to unipolar total hip replacement bearings in the hip fracture population out to six years at which point the numbers fall below 250 in the dual mobility group. While the difference here is not significant, it is interesting that this is a different pattern seen to that for dual mobility bearings in cemented and uncemented fixation groups in elective total hip replacement where the early revision rates appear higher in the dual mobility bearings.

Figure 3.H13 (page 113) shows a markedly higher overall mortality in total hip replacements performed for hip fracture cases compared to cases implanted for osteoarthritis only (P<0.001, logrank test). As in the overall mortality section, the second of 5,790 simultaneous bilateral procedures were excluded. Gender and age differences did not fully explain the difference seen, as a stratified analysis still showed a difference (P<0.001).

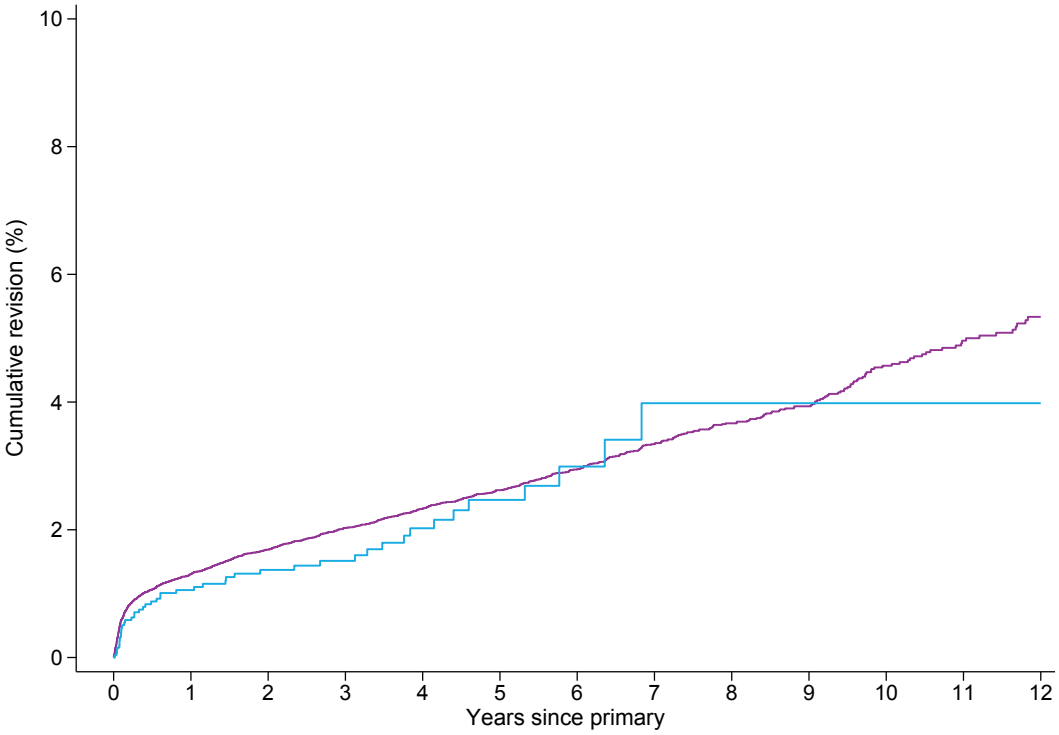
Figure 3.H12 (a) KM estimates of cumulative revision for fractured neck of femur and osteoarthritis only cases for primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

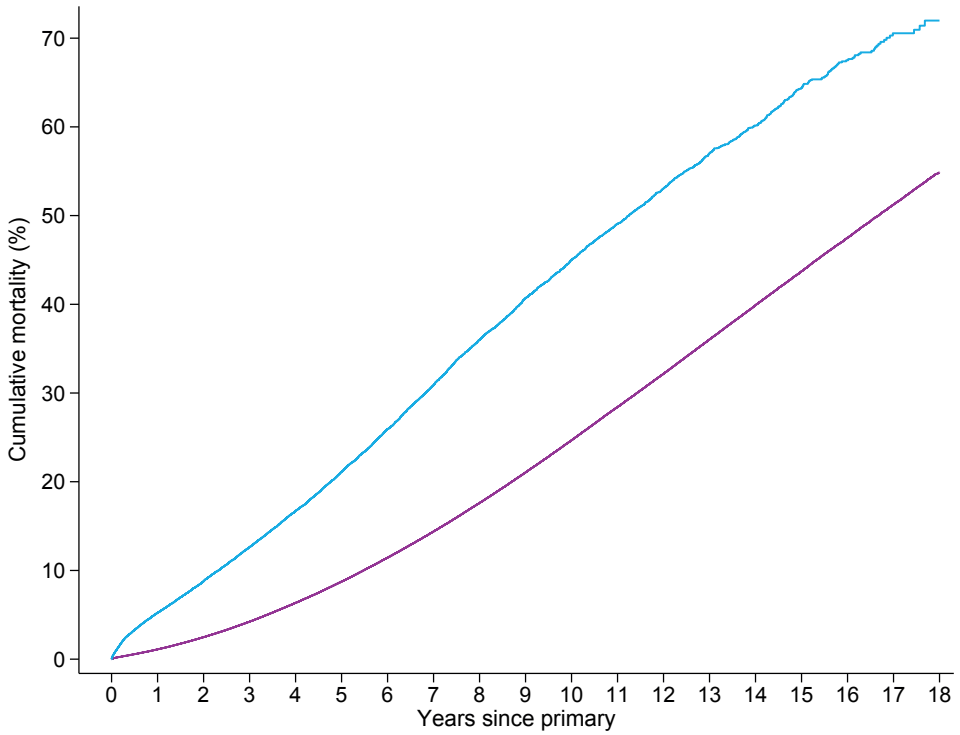
	Numbers at risk									
Osteoarthritis only	1,183,460	1,024,801	820,809	626,538	453,009	307,801	189,417	97,981	37,425	5,494
Fractured neck of femur	50,008	37,397	24,674	14,546	7,559	3,548	1,711	728	*224*	*27*

Figure 3.H12 (b) KM estimates of cumulative revision by bearing type for fractured neck of femur cases in primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk						
Unipolar bearings	47,394	35,766	23,879	14,263	7,500	3,536	1,708
Dual mobility	2,614	1,631	795	283	*59*	*12*	*<4*

Figure 3.H13 KM estimates of cumulative mortality for fractured neck of femur and osteoarthritis only in primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

Numbers at risk

Osteoarthritis only	1,178,420	1,031,235	831,001	639,172	466,963	321,720	202,062	106,113	40,742	5,955
Fractured neck of femur	49,974	37,977	25,196	14,960	7,855	3,757	1,844	802	251	*30*

3.2.8 Overview of hip revisions

In this section we look at all hip revision procedures performed since the start of the registry, 1 April 2003, up to 31 December 2021, for all patients with valid patient identifiers (i.e. whose data could therefore be linked).

In total, there were 135,690 revisions on 115,740 individual patient sides (108,750 actual patients). In addition to the 40,387 first revised primary hip replacements described in section 3.2.2 of this report, there were 87,001 revision procedures for which no primary hip replacement had been recorded in the registry.

Revisions are classified as single-stage, stage one and stage two of two-stage revisions. Information on stage one and stage two revisions are entered into the registry separately, whereas in practice a stage two revision has to be linked to a preceding stage one revision. Although not all patients who undergo a stage one of two revision will undergo a stage two of two revision, in some cases stage one revisions have been entered without a stage two, and vice versa, making identification of individual revision episodes difficult. We have attempted to do this later in this section.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

Table 3.H14 Number and percentage of hip revisions by procedure type and year.

Year of revision surgery	Type of revision procedure			All procedures
	Single-stage N(%)	Stage one of two-stage N(%)	Stage two of two-stage N(%)	
2003*	16 (1.1)	0 (0.0)	1,454 (98.9)	1,470
2004	1,843 (65.7)	120 (4.3)	841 (30.0)	2,804
2005	3,507 (87.3)	204 (5.1)	305 (7.6)	4,016
2006	4,200 (86.8)	269 (5.6)	372 (7.7)	4,841
2007	5,618 (87.5)	341 (5.3)	463 (7.2)	6,422
2008	6,057 (86.2)	421 (6.0)	550 (7.8)	7,028
2009	6,323 (84.3)	516 (6.9)	661 (8.8)	7,500
2010	7,050 (86.5)	502 (6.2)	598 (7.3)	8,150
2011	7,978 (87.5)	530 (5.8)	611 (6.7)	9,119
2012	9,254 (88.1)	604 (5.7)	650 (6.2)	10,508
2013	8,540 (87.8)	567 (5.8)	623 (6.4)	9,730
2014	8,408 (87.0)	667 (6.9)	594 (6.1)	9,669
2015	8,021 (86.0)	709 (7.6)	597 (6.4)	9,327
2016	7,731 (87.3)	587 (6.6)	539 (6.1)	8,857
2017	7,704 (87.2)	614 (6.9)	518 (5.9)	8,836
2018	7,467 (87.6)	573 (6.7)	480 (5.6)	8,520
2019	7,207 (87.4)	568 (6.9)	469 (5.7)	8,244
2020	4,366 (86.1)	412 (8.1)	291 (5.7)	5,069
2021	4,870 (87.3)	383 (6.9)	327 (5.9)	5,580
Total	**116,160 (85.6)**	**8,587 (6.3)**	**10,943 (8.1)**	**135,690**

*Incomplete year
Note: Single-stages include DAIRs (Debridement And Implant Retention) and hip excision arthroplasty.

Table 3.H14 gives an overview of all hip replacement revision procedures carried out each year since April 2003. There were a maximum number of 14 documented revision procedures associated with any individual patient side (making up eleven revision episodes as two episodes consisted of a stage one of a two-stage procedure and a stage two of a two-stage procedure).

The incidence of revision hip replacement peaked in 2012 and has steadily declined since then, despite the increasing number of at-risk implants prevailing in the dataset. In the COVID-19 impacted years of 2020 and 2021, the number of revision hip replacements performed were approximately half of the peak rate observed in 2012. This is likely to be multifactorial as the impact of the peak use of metal-on-metal in 2008 worked its way through the subsequent observed revision rates.

Table 3.H15 (a) Number and percentage of hip revision by indication and procedure type.

Reason	Type of revision procedure		
	Single-stage N(%) (n=116,160)	Stage one of two-stage N(%) (n=8,587)	Stage two of two-stage N(%) (n=10,943)
Aseptic loosening	53,562 (46.1)	995 (11.6)	2,338 (21.4)
Dislocation / Subluxation	19,244 (16.6)	350 (4.1)	552 (5.0)
Pain	18,366 (15.8)	824 (9.6)	926 (8.5)
Lysis	17,026 (14.7)	761 (8.9)	711 (6.5)
Implant wear	16,148 (13.9)	345 (4.0)	421 (3.8)
Periprosthetic fracture	14,444 (12.4)	341 (4.0)	488 (4.5)
Other indication	7,936 (6.8)	284 (3.3)	856 (7.8)
Malalignment	6,248 (5.4)	116 (1.4)	116 (1.1)
Infection	5,974 (5.1)	7,061 (82.2)	6,760 (61.8)
Implant fracture	4,290 (3.7)	89 (1.0)	169 (1.5)
Head-socket size mismatch	782 (0.7)	22 (0.3)	27 (0.2)
Adverse reaction to particulate debris*	10,677 (10.7) n=99,951	253 (3.3) n=7,577	173 (2.3) n=7,443

*Not recorded in the early phase of the registry; MDSv3, v6 and v7 only.

Table 3.H15 (b) Number and percentage of hip revision by indication and procedure type in last five years.

Reason	Type of revision procedure		
	Single-stage N(%) (n=31,617)	Stage one of two-stage N(%) (n=2,550)	Stage two of two-stage N(%) (n=2,085)
Aseptic loosening	11,920 (37.7)	196 (7.7)	158 (7.6)
Dislocation / Subluxation	6,128 (19.4)	106 (4.2)	65 (3.1)
Periprosthetic fracture	5,794 (18.3)	115 (4.5)	115 (5.5)
Implant wear	4,150 (13.1)	75 (2.9)	33 (1.6)
Lysis	3,988 (12.6)	190 (7.5)	83 (4.0)
Adverse reaction to particulate debris	3,213 (10.2)	93 (3.6)	49 (2.4)
Infection	2,712 (8.6)	2,225 (87.3)	1,695 (81.3)
Malalignment	1,486 (4.7)	26 (1.0)	9 (0.4)
Other indication	1,400 (4.4)	68 (2.7)	124 (5.9)
Implant fracture	1,250 (4.0)	21 (0.8)	15 (0.7)
Pain	1,241 (3.9)	38 (1.5)	24 (1.2)
Head-socket size mismatch	121 (0.4)	<4 (0.1)	<4 (0.0)

Table 3.H15 (a) shows the stated indication for the revision hip replacement surgery. Please note that, as several indications can be stated, the indications are not mutually exclusive and therefore column percentages may not add up to 100%. Aseptic loosening is the most common indication for revision.

Table 3.H15 (b) shows the stated indication for revision hip replacement surgery performed in the last five years (1,826 days). The most notable difference between all the data and that recorded in the last five years is surgeons citing pain as an indication for revision, falling from 15.8% to 3.9% of single-stage revisions. There is also a higher proportion of cases revised for periprosthetic fracture in the last five years (18.3% compared to 12.4%) and a higher proportion of cases revised due to infection (8.6% compared to 5.1%). The ratio of stage two of two-stage, stage one of two-stage and single-stage revisions overall (1:0.78:10.6) is different compared to those performed in the last five years (1:1.22:15.2).

3.2.9 Rates of hip re-revision

In most instances (89.9% of 115,740 individual patient-sides), the first revision procedure was a single-stage revision, however in the remaining 10.1% it was part of a two-stage procedure. For a given patient side, survival following the first documented revision hip replacement procedure for those with a linked primary in the registry (n=40,387) has been analysed. This analysis is restricted to patients with a linked primary procedure so that there is confidence that the next observed procedure on the same joint is the first revision episode. If there is no linked primary record in the dataset, it cannot be determined if the first observed revision is the first revision or if it has been preceded by other revision episodes. The time from the first documented revision procedure (of any type) to the time at which a second revision episode was undertaken has been determined. For this purpose, an initial stage one followed by either a stage one or a stage two have been considered to be the same revision episode and these were disregarded, looking instead for the start of a second revision episode (the maximum number of distinct revision episodes was determined to be 11 for any patient side).

Kaplan-Meier estimates of the cumulative percentage probability of having a subsequent revision (re-revision) were calculated. There were 4,667 re-revisions and for 7,241 cases the patient died without having been re-revised. The censoring date for the remainder was the end of 2021.

Figure 3.H14 (a) plots Kaplan-Meier estimates of the cumulative probability of a subsequent revision between 1 and 18 years since the primary operation.

Figure 3.H14 (a) KM estimates of cumulative re-revision in linked primary hip replacements (shaded area indicates point-wise 95% CI). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

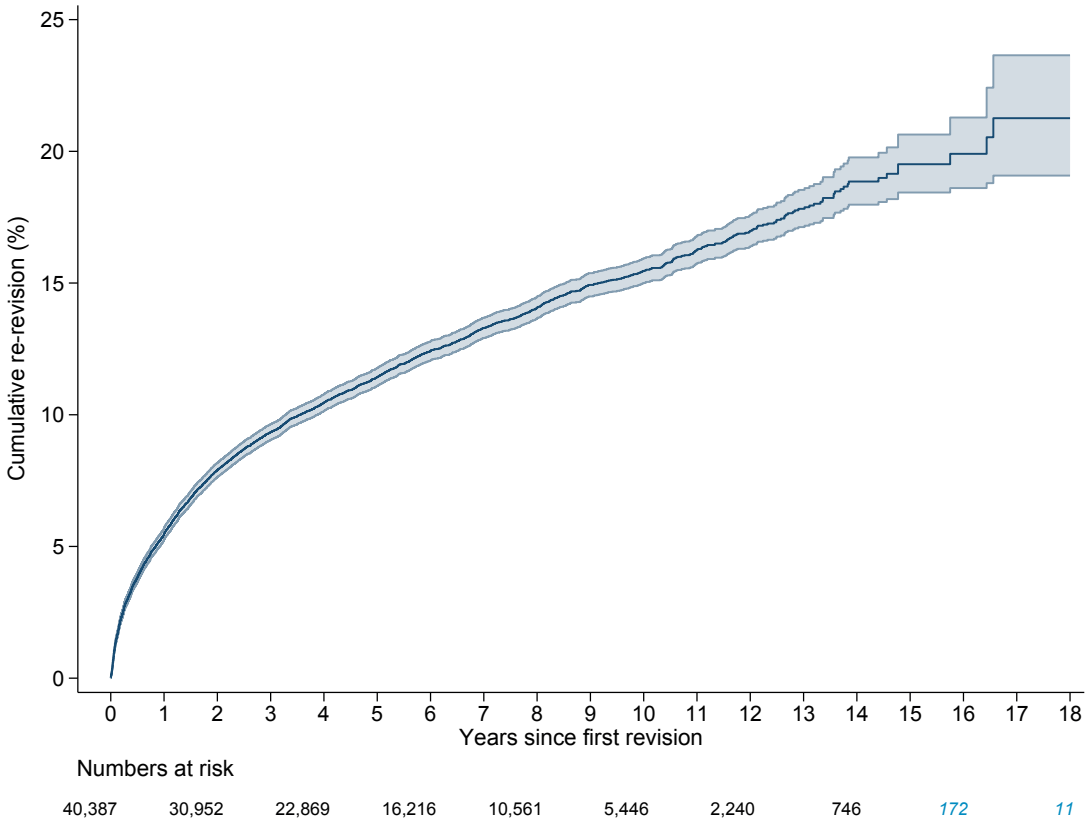
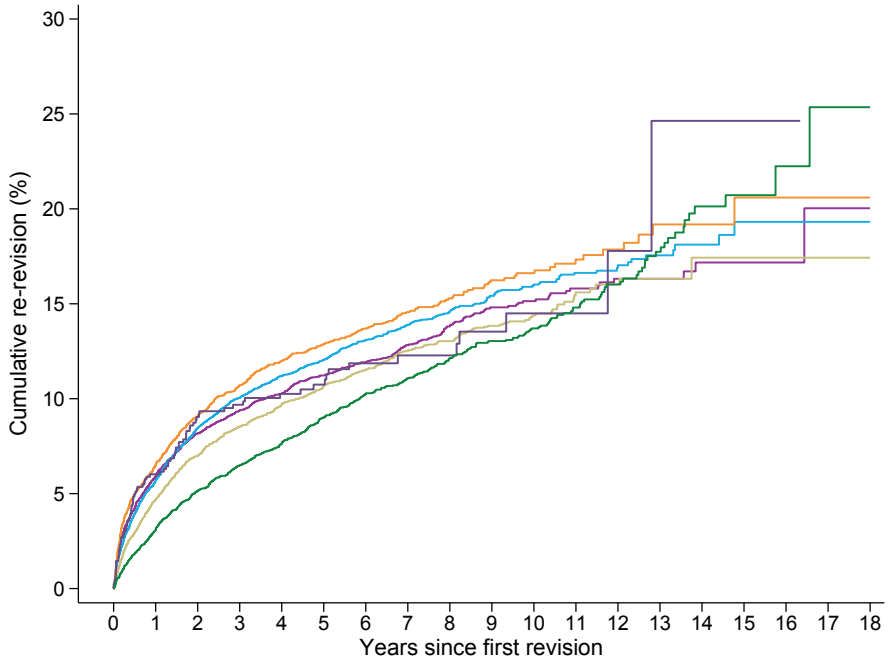


Figure 3.H14 (b) KM estimates of cumulative re-revision by primary fixation in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



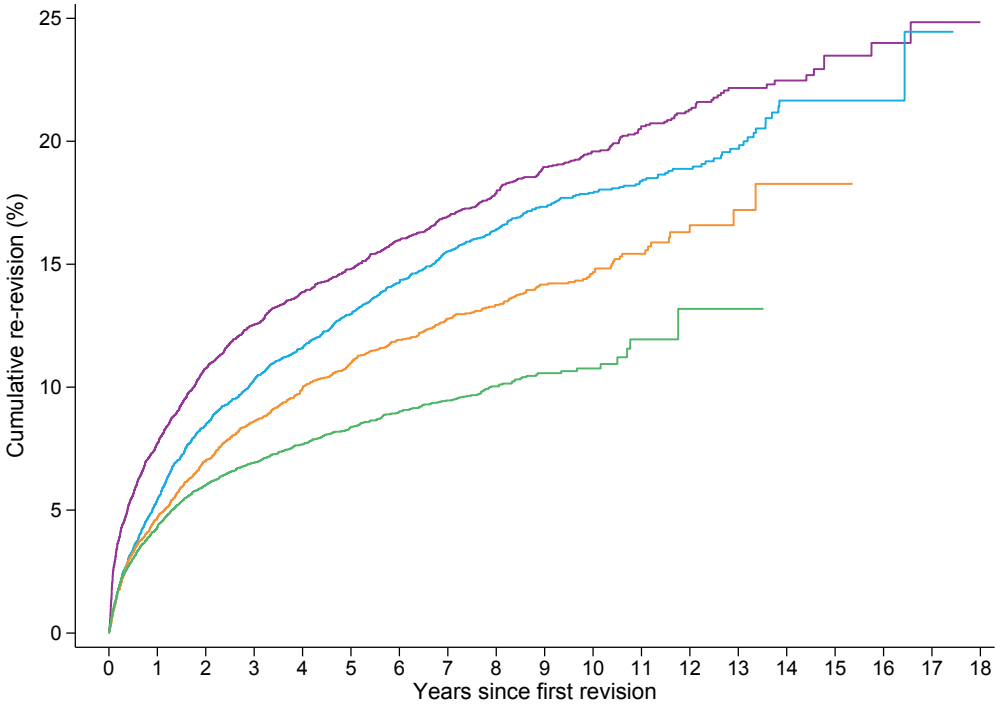
Key:

	Numbers at risk									
Cemented	9,319	6,700	4,548	2,913	1,737	896	430	*162*	*36*	*<4*
Uncemented without MoM	11,844	8,938	6,425	4,383	2,640	1,352	578	*193*	*48*	*<4*
Uncemented MoM	5,640	4,848	4,038	3,236	2,253	1,000	284	*60*	*9*	*<4*
Hybrid	6,298	4,375	2,884	1,793	1,032	558	*241*	*89*	*24*	*<4*
Reverse hybrid	827	604	412	261	*150*	*63*	*23*	*5*	*<4*	
Resurfacing	4,723	4,191	3,580	2,897	2,230	1,267	553	*189*	*44*	*4*

Figure 3.H14 (b) shows estimates of re-revision by type of primary hip replacement. Resurfacing has the lowest re-revision rate until approximately eight years, after which the revision rate appears to be worse than that associated with alternatives. However, after 12 years the numbers at risk are low and should therefore be interpreted with caution. Uncemented primary total hip replacements have similar rates of re-revision to alternatives up until two years, after that the observed rates of re-revision are higher than alternatives until 12 years when the numbers at risk become small.

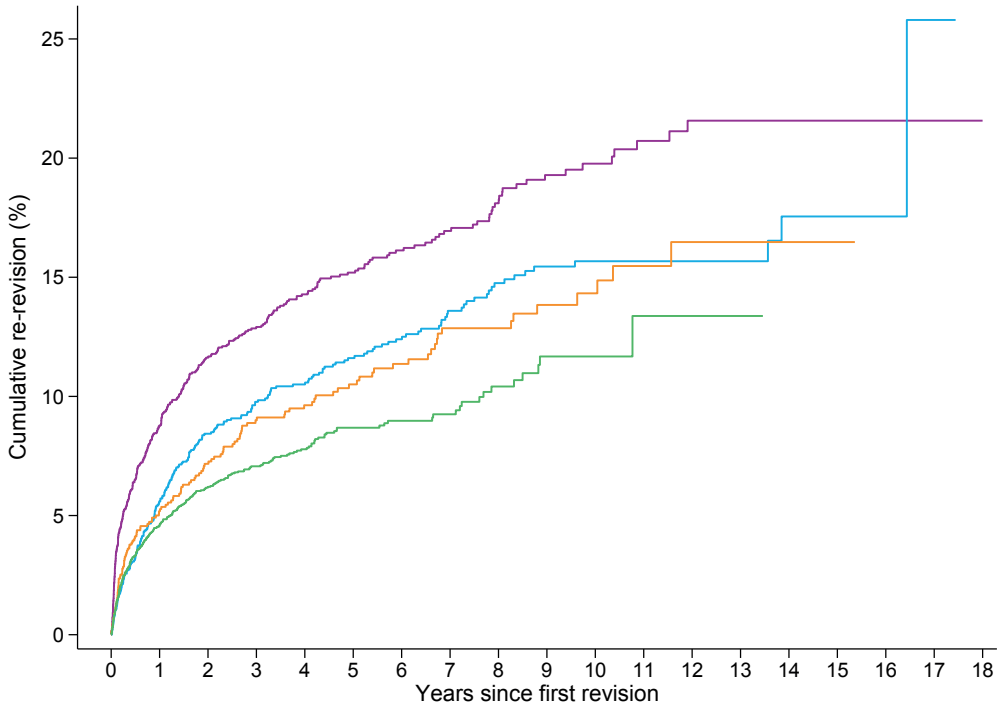
Figure 3.H14 (c) shows the relationship between time to first revision and the risk of subsequent revision. The earlier the primary hip replacement is revised, the higher the risk of a second revision. There is a relationship between the indication for first revision and time to first revision; earlier in this report (section 3.2.5) we show, for example, that revisions for dislocation / subluxation, infection and malalignment were more prevalent in the early period after the primary hip replacement, and aseptic loosening and lysis later on.

Figure 3.H14 (c) KM estimates of cumulative re-revision by years to first revision, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
First rev. <1y	10,559	8,019	5,937	4,251	2,885	1,839	1,041	426	*130*	*11*
First rev. 1 to 3y	7,598	6,120	4,881	3,790	2,798	1,860	857	280	*42*	
First rev. 3 to 5y	5,883	4,798	3,932	3,183	2,426	1,174	294	*40*		
First rev. ≥5y	16,347	12,015	8,119	4,992	2,452	573	*48*			

Figure 3.H15 (a) KM estimates of cumulative re-revision in cemented primary hip replacement by years to first revision, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



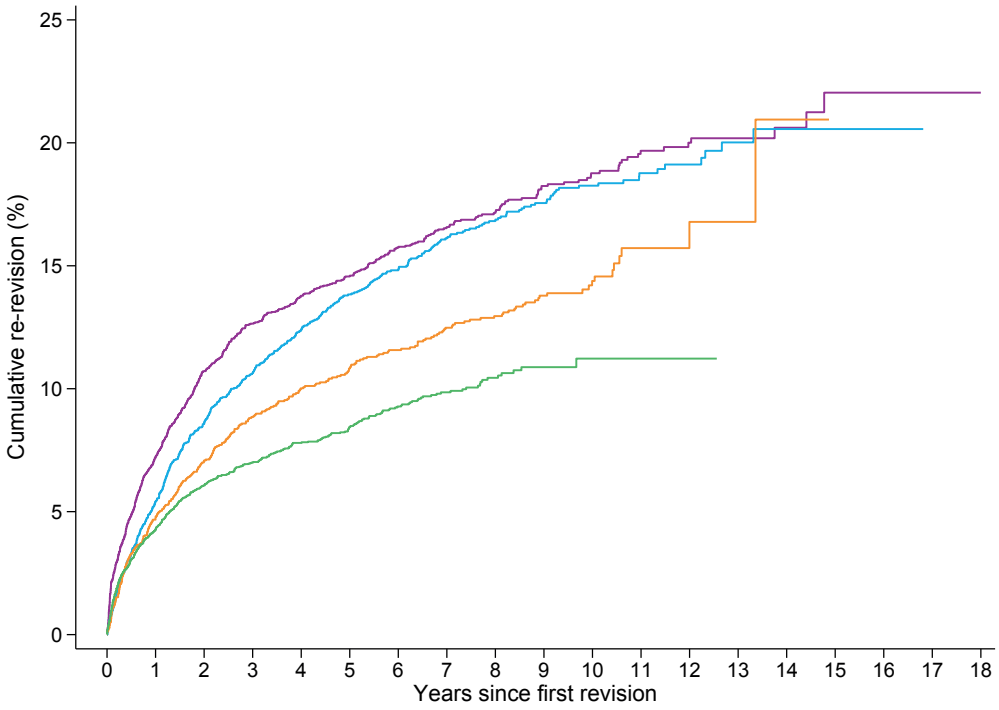
Key:

Numbers at risk

First rev. <1y	2,296	1,904	1,683	1,434	1,196	989	806	654	521	406	297	*218*	*169*	*114*	*76*	*45*	*25*	*11*	*<4*
First rev. 1 to 3y	1,864	1,610	1,446	1,279	1,115	952	817	673	541	434	338	260	*180*	*125*	*71*	*32*	*11*	*4*	
First rev. 3 to 5y	1,245	1,051	928	781	673	560	461	382	306	*221*	*159*	*112*	*66*	*35*	*15*	*<4*			
First rev. ≥5y	3,914	3,115	2,643	2,062	1,564	1,159	829	569	369	*229*	*102*	*40*	*15*	*<4*					

For those with a documented primary hip replacement within the registry, Figures 3.H15 (a) to (e) show cumulative re-revision rates following the first revision hip replacement, according to the main fixation used in the primary. Each sub-group has been further sub-divided according to the time interval from the primary hip replacement to the first revision, i.e. less than 1 year, 1 to <3, 3 to <5 and greater than or equal to 5 years. For cemented, uncemented, hybrid, reverse hybrid and resurfacing hip replacements, there was a trend of higher observed re-revision rates in those that had their first revision within one year, between one and three years or three to five years of the initial primary hip replacement.

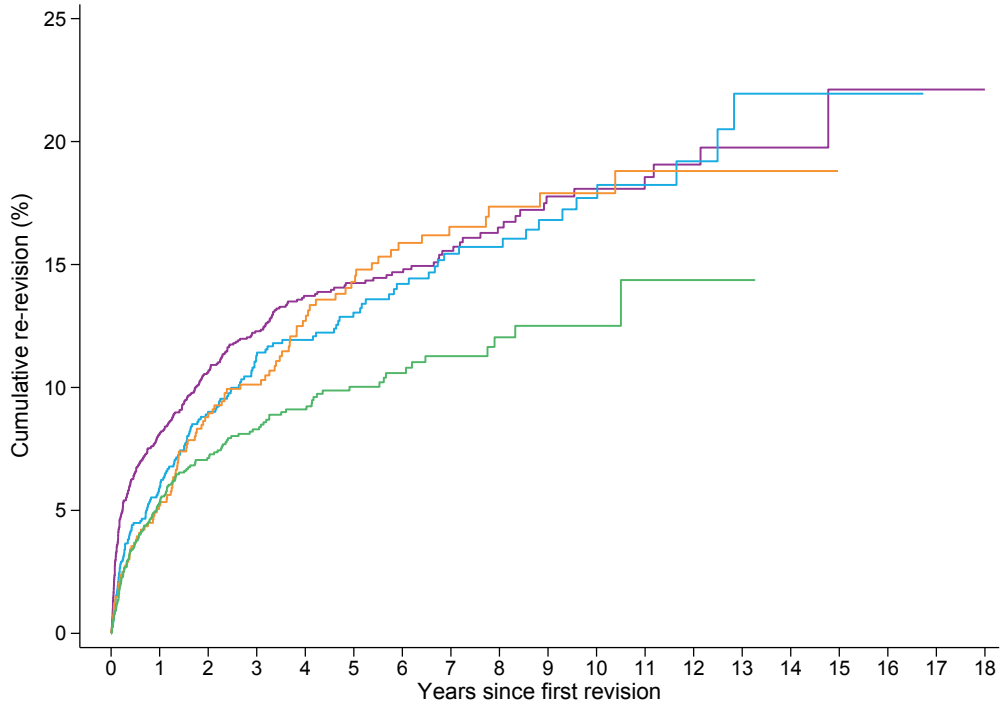
Figure 3.H15 (b) KM estimates of cumulative re-revision in uncemented primary hip replacement by years to first revision, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk																		
First rev. <1y	4,598	4,010	3,628	3,197	2,804	2,439	2,077	1,727	1,419	1,132	864	630	448	276	*153*	*79*	*45*	*19*	*4*
First rev. 1 to 3y	3,321	3,012	2,773	2,495	2,261	2,023	1,803	1,542	1,328	1,104	845	567	331	*182*	*90*	*37*	*12*		
First rev. 3 to 5y	2,650	2,391	2,229	2,035	1,874	1,716	1,562	1,373	1,181	875	480	*181*	*78*	*32*	*10*				
First rev. ≥5y	6,915	5,831	5,156	4,336	3,524	2,837	2,177	1,543	965	502	*163*	*40*	*5*						

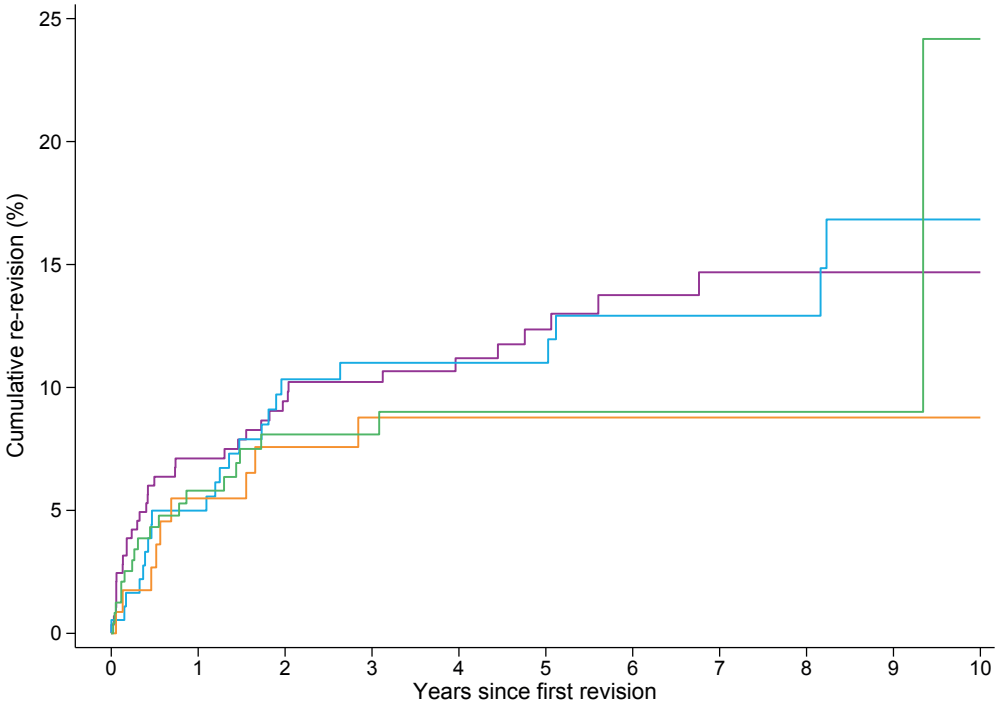
Figure 3.H15 (c) KM estimates of cumulative re-revision in hybrid primary hip replacement by years to first revision, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk																	
First rev. <1y	2,441	1,965	1,710	1,402	1,118	890	691	500	376	298	*232*	*171*	*121*	*76*	*50*	*31*	*17*	*8*	*<4*
First rev. 1 to 3y	1,248	1,052	889	726	614	504	393	312	254	*209*	*156*	*105*	*77*	*52*	*34*	*16*	*7*		
First rev. 3 to 5y	812	671	573	489	409	344	294	*241*	*187*	*141*	*106*	*68*	*35*	*11*	*5*				
First rev. ≥5y	1,797	1,420	1,203	968	743	583	415	302	*215*	*141*	*64*	*33*	*8*	*<4*					

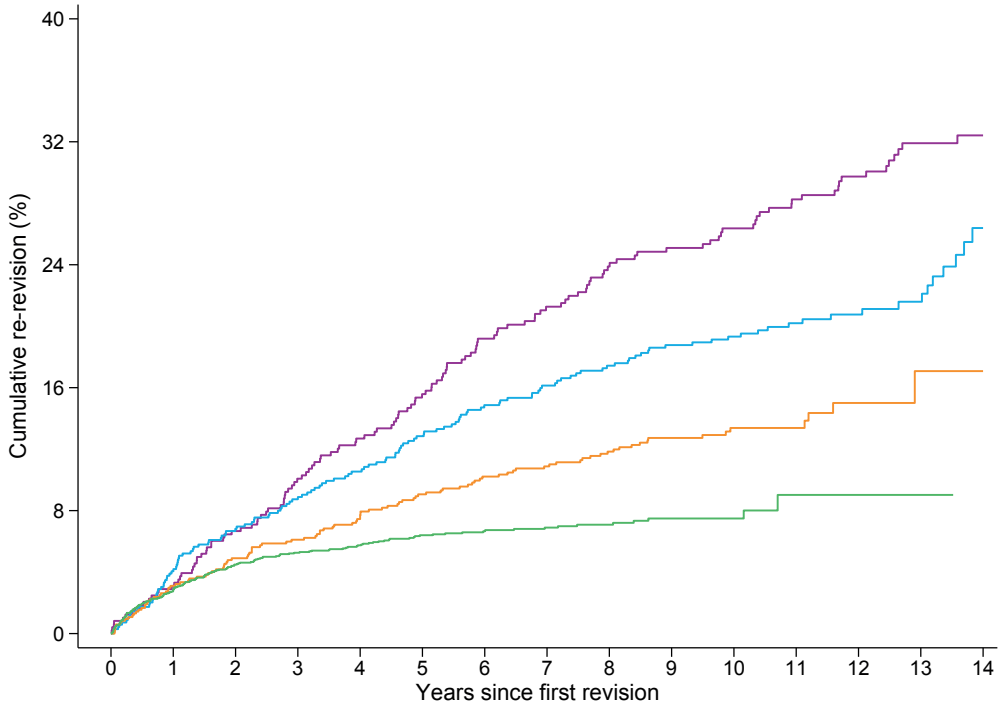
Figure 3.H15 (d) KM estimates of cumulative re-revision in reverse hybrid primary hip replacement by years to first revision, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk										
First rev. <1y	286	*245*	*231*	*207*	*167*	*137*	*105*	*88*	*70*	*47*	*29*
First rev. 1 to 3y	*184*	*167*	*145*	*125*	*115*	*93*	*78*	*62*	*46*	*35*	*21*
First rev. 3 to 5y	*115*	*97*	*87*	*76*	*59*	*47*	*39*	*28*	*16*	*12*	*9*
First rev. ≥5y	*242*	*178*	*141*	*105*	*71*	*55*	*39*	*26*	*18*	*9*	*4*

Figure 3.H15 (e) KM estimates of cumulative re-revision in resurfacing primary hip replacement by years to first revision, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

Numbers at risk

First rev. <1y	485	465	442	419	397	376	357	335	318	303	283	259	*218*	*166*	*114*
First rev. 1 to 3y	694	662	637	613	587	565	545	523	505	470	415	312	*221*	*150*	*66*
First rev. 3 to 5y	841	809	792	776	753	726	687	663	623	525	364	*202*	*98*	*33*	*9*
First rev. ≥5y	2,703	2,476	2,320	2,094	1,843	1,576	1,308	1,073	784	494	*205*	*64*	*16*	*<4*	

Table 3.H16 (a) shows the re-revision rate of the 40,387 primary hip replacements in the registry that were revised. Of these, 4,667 were re-revised, Table 3.H16 (b) shows that primary hip replacements that fail within the first year after surgery have just under twice the chance of needing re-revision at each time point compared with primaries that last more than five years.

Table 3.H16 (a) KM estimates of cumulative re-revision (95% CI). *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

	Number of first revised joints at risk of re-revision	Time since first revision					
		1 year	3 years	5 years	10 years	15 years	18 years
Primary recorded in the registry	40,387	5.48 (5.25-5.71)	9.33 (9.04-9.64)	11.43 (11.09-11.78)	15.46 (15.00-15.93)	19.51 (18.44-20.64)	*21.26 (19.08-23.65)*

Table 3.H16 (b) KM estimates of cumulative re-revision (95% CI) by years since first revision. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Primary in the registry where the first revision took place:	Number of first revised joints at risk of re-revision	Time since first revision						
		1 year	3 years	5 years	7 years	10 years	13 years	15 years
<1 year after primary	10,559	7.71 (7.21-8.24)	12.55 (11.91-13.23)	14.81 (14.09-15.56)	16.95 (16.15-17.78)	19.59 (18.64-20.58)	22.17 (20.96-23.44)	*23.48 (21.91-25.15)*
1 to <3 years after primary	7,598	5.43 (4.94-5.98)	10.28 (9.60-11.02)	12.98 (12.19-13.81)	15.52 (14.63-16.45)	17.90 (16.89-18.96)	19.69 (18.46-21.00)	*21.66 (19.97-23.46)*
3 to <5 years after primary	5,883	4.71 (4.19-5.30)	8.60 (7.89-9.38)	10.98 (10.16-11.87)	12.78 (11.87-13.76)	14.68 (13.63-15.80)	*17.21 (15.37-19.23)*	
≥5 years after primary	16,347	4.30 (3.99-4.63)	6.93 (6.53-7.36)	8.38 (7.92-8.87)	9.46 (8.93-10.02)	10.76 (10.06-11.50)		

Note: Maximum interval was 18.6 years.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Data have not been presented at 18 years due to low numbers.

Table 3.H16 (c) KM estimates of cumulative re-revision (95% CI) by fixation and bearing used in primary hip replacement. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Fixation and bearing surface	N	Time since first revision						
		1 year	3 years	5 years	7 years	10 years	13 years	15 years
All	**40,387**	**5.48 (5.25-5.71)**	**9.33 (9.04-9.64)**	**11.43 (11.09-11.78)**	**13.29 (12.91-13.69)**	**15.46 (15.00-15.93)**	**17.82 (17.12-18.53)**	**19.51 (18.44-20.64)**
All cemented	**9,319**	**5.94 (5.46-6.45)**	**9.38 (8.77-10.03)**	**11.22 (10.53-11.97)**	**12.82 (12.02-13.68)**	**15.14 (14.11-16.24)**	**16.32 (15.05-17.68)**	*17.17 (15.50-19.02)*
MoP	8,319	5.93 (5.43-6.47)	9.25 (8.61-9.94)	10.98 (10.25-11.76)	12.59 (11.75-13.49)	14.85 (13.77-15.99)	15.79 (14.53-17.14)	*16.72 (14.98-18.65)*
CoP	908	5.96 (4.56-7.77)	10.79 (8.80-13.20)	13.49 (11.13-16.30)	*14.78 (12.18-17.89)*	*18.02 (14.46-22.35)*	*22.02 (16.24-29.47)*	
All uncemented	**17,484**	**5.36 (5.03-5.71)**	**9.54 (9.09-10.00)**	**11.60 (11.09-12.12)**	**13.45 (12.89-14.04)**	**15.45 (14.77-16.16)**	**17.14 (16.20-18.14)**	*18.78 (17.05-20.66)*
MoP	5,093	5.54 (4.93-6.22)	9.83 (8.99-10.73)	11.31 (10.39-12.30)	13.63 (12.53-14.82)	15.45 (14.11-16.91)	*16.48 (14.75-18.39)*	*19.20 (15.19-24.10)*
MoM	5,640	4.66 (4.14-5.25)	8.53 (7.81-9.31)	10.67 (9.86-11.55)	12.52 (11.62-13.49)	14.39 (13.34-15.52)	*16.31 (14.82-17.94)*	*17.43 (14.94-20.28)*
CoP	2,394	5.95 (5.05-7.00)	10.72 (9.47-12.13)	12.49 (11.08-14.07)	13.45 (11.92-15.15)	*15.40 (13.44-17.61)*	*16.80 (14.14-19.91)*	*16.80 (14.14-19.91)*
CoC	4,111	5.59 (4.92-6.35)	9.74 (8.84-10.74)	12.27 (11.23-13.40)	14.05 (12.89-15.30)	16.35 (14.94-17.87)	*18.42 (16.47-20.57)*	*20.41 (17.19-24.14)*
All hybrid	**6,298**	**6.52 (5.92-7.17)**	**10.70 (9.91-11.55)**	**12.88 (11.97-13.85)**	**14.57 (13.52-15.68)**	**16.61 (15.31-18.01)**	*19.18 (17.06-21.53)*	*20.60 (17.33-24.39)*
MoP	3,616	6.71 (5.92-7.59)	10.60 (9.57-11.72)	12.62 (11.45-13.90)	14.23 (12.90-15.69)	16.16 (14.52-17.97)	*18.23 (15.84-20.94)*	*20.39 (16.02-25.75)*
MoM	423	3.90 (2.41-6.29)	9.61 (7.08-12.97)	12.64 (9.66-16.45)	*14.52 (11.24-18.65)*	*17.22 (13.38-22.01)*	*18.35 (14.10-23.70)*	
CoP	1,461	6.76 (5.55-8.22)	10.73 (9.11-12.62)	13.35 (11.37-15.64)	*14.05 (11.89-16.57)*	*14.99 (12.30-18.20)*	*14.99 (12.30-18.20)*	
CoC	714	6.04 (4.50-8.09)	10.63 (8.49-13.26)	11.89 (9.59-14.70)	*14.47 (11.71-17.81)*	*16.95 (13.48-21.20)*	*23.45 (16.28-33.10)*	
All reverse hybrid	**827**	**6.02 (4.57-7.91)**	**9.68 (7.76-12.04)**	**10.74 (8.66-13.29)**	*12.28 (9.89-15.19)*	*14.49 (11.27-18.54)*	*24.64 (13.37-42.72)*	
MoP	555	5.83 (4.14-8.19)	9.49 (7.20-12.45)	*10.47 (7.99-13.65)*	*12.91 (9.84-16.85)*	*15.64 (11.25-21.53)*		
All resurfacing	**4,723**	**3.10 (2.64-3.64)**	**6.48 (5.80-7.23)**	**9.02 (8.20-9.92)**	**11.08 (10.15-12.09)**	**13.71 (12.60-14.90)**	**17.74 (15.99-19.65)**	*20.72 (18.20-23.54)*
Unconfirmed	**1,736**	**6.70 (5.59-8.02)**	**9.87 (8.49-11.46)**	**12.10 (10.52-13.90)**	**15.04 (13.19-17.14)**	**16.76 (14.68-19.10)**	*19.11 (16.32-22.31)*	*19.11 (16.32-22.31)*

Note: Maximum interval was 18.6 years.
Note: Data have not been presented for 18 years due to low numbers.

Table 3.H16 (c) shows cumulative re-revision rates at 1, 3, 5, 7, 10, 13 and 15 years following the first revision for those with documented primary hip replacements within the registry, broken down by fixation types and bearing surfaces used in the primary hip replacement.

The revision rates for revisions following resurfacings were comparatively low, but Figure 3.H14 (b) (page 118) shows that after ten years the revision rate is becoming higher than those for alternatives.

3.2.10 Reasons for hip re-revision

Tables 3.H17 (a) and (b) show a breakdown of the stated indications for the first revision and for any second revision. Please note the indications are not mutually exclusive. Table 3.H17 (a) shows the indications for recorded revisions in the registry and Table 3.H17 (b) reports the indications for the first linked revision and the number and percentage of first linked revisions that were subsequently revised. In the final column in Table 3.H17 (b), we report the indications for all the second linked revisions e.g. 975 linked second revisions recorded aseptic loosening as an indication. It is interesting to note that both dislocation and infection are much more common indications for a second revision than for a first revision. This shows the increased risk of instability and infection following the first revision of a hip replacement compared to that of primary hip replacement.

Table 3.H17 (a) Number of revisions by indication for all revisions.

Reason for revision	All recorded revisions, N(%)
Aseptic loosening	56,895 (41.9)
Dislocation / Subluxation	20,146 (14.8)
Pain	20,116 (14.8)
Infection	19,795 (14.6)
Lysis	18,498 (13.6)
Implant wear	16,914 (12.5)
Periprosthetic fracture	15,273 (11.3)
Malalignment	6,480 (4.8)
Implant fracture	4,548 (3.4)
Head/socket size mismatch	831 (0.6)
Other indication	9,076 (6.7)
Adverse reaction to particulate debris*	11,103 (8.2)

*Adverse reaction to particulate debris was only recorded using MDSv3 onwards and as such was only a potential reason for revision among a total of 114,971 revisions as opposed to 135,690 revisions for the other reasons.

Table 3.H17 (b) Number of revisions by indication for first linked revision and second linked re-revision.

	First linked revision		Second linked revision
Reason for revision	N	Subsequently re-revised, N(%)	N
Aseptic loosening	9,962	973 (9.8)	975
Dislocation / Subluxation	7,028	835 (11.9)	1,155
Periprosthetic fracture	6,355	652 (10.3)	411
Infection	6,159	1,092 (17.7)	1,483
Pain	5,019	645 (12.9)	425
Malalignment	2,679	266 (9.9)	221
Lysis	2,437	204 (8.4)	199
Implant wear	2,279	205 (9.0)	226
Implant fracture	1,306	147 (11.3)	138
Head/socket size mismatch	262	40 (15.3)	16
Other indication	3,226	438 (13.6)	291
Adverse reaction to particulate debris*	2,715	263 (9.7)	126

*Adverse reaction to particulate debris was only recorded using MDSv3 onwards and as such was only a potential reason for revision among a total of 26,285 revisions as opposed to 40,387 revisions for the other reasons.

Tables 3.H18 (a) and (b) (page 129) show that the numbers of revisions and the relative proportion of revisions with a linked primary in the registry increased with time. Approximately 57% of revisions performed in 2021 had a linked primary in the registry. This is likely to reflect improved data capture over time, improved linkability of records and the longevity of hip replacements with a proportion of primaries being revised being performed before data capture began or being outside the coverage of the registry.

Table 3.H18 (a) Number of revisions by year.

Year of first revision in the registry*	Number of first revisions*	Number of first revisions (%) with the associated primary recorded in the registry
2003	1,447	43 (3.0)
2004	2,712	144 (5.3)
2005	3,797	306 (8.1)
2006	4,482	462 (10.3)
2007	5,916	815 (13.8)
2008	6,326	1,161 (18.4)
2009	6,564	1,516 (23.1)
2010	7,074	1,957 (27.7)
2011	7,943	2,665 (33.6)
2012	9,027	3,349 (37.1)
2013	8,227	3,059 (37.2)
2014	8,084	3,106 (38.4)
2015	7,658	3,245 (42.4)
2016	7,271	3,241 (44.6)
2017	7,182	3,348 (46.6)
2018	6,916	3,536 (51.1)
2019	6,644	3,572 (53.8)
2020	4,021	2,316 (57.6)
2021	4,449	2,546 (57.2)
Total	115,740	40,387 (34.9)

*First documented revision in the registry.

Table 3.H18 (b) Number of revisions by year, stage, and whether or not primary is in the registry.

Year of first revision in the registry*	Single-stage		First documented stage of two-stage	
	Primary not in the registry	Primary in the registry	Primary not in the registry	Primary in the registry
2003	16	0	1,388	43
2004	1,716	94	852	50
2005	3,161	251	330	55
2006	3,645	374	375	88
2007	4,653	687	448	128
2008	4,694	960	471	201
2009	4,572	1,253	476	263
2010	4,705	1,726	412	231
2011	4,887	2,397	391	268
2012	5,301	3,021	377	328
2013	4,855	2,759	313	300
2014	4,629	2,811	349	295
2015	4,107	2,919	306	326
2016	3,794	2,954	236	287
2017	3,586	3,074	248	274
2018	3,153	3,282	227	254
2019	2,886	3,299	186	273
2020	1,569	2,112	136	204
2021	1,771	2,350	132	196
Total	67,700	36,323	7,653	4,064

*First documented revision in the registry.

3.2.11 90-day mortality after hip revision

The overall cumulative percentage mortality at 90 days after hip revision was lower in the cases with a primary hip replacement recorded in the registry compared with the remainder (Kaplan-Meier estimates 1.53% (95% CI 1.42-1.66) versus 1.96% (95% CI 1.87- 2.06)), which may reflect the fact that patients in this group were younger at the time of their first revision, median age of 70 (IQR 61 to 77) years compared to the group without primaries documented in the registry who had a median age of 74 (IQR 66 to 80) years. The percentage of males to females was similar in both groups (44.2% versus 42.5% respectively).

3.2.12 Conclusions

As in previous annual reports, our analysis of implants has been by revision of the construct, rather than revision of a single component, as the mechanisms of failure (such as wear, adverse reaction to particulate debris and dislocation) are interdependent between different parts of the construct. Revision analyses have also been stratified by age and gender. The highest revision rates are among younger females and the lowest among older females. When data on metal-on-metal are excluded, younger females have similar revision rates to younger males. Once again, it must be emphasised that implant survivorship is only one measure of success and cannot be used as an indication of satisfaction, relief of pain, improvement in function and the resulting greater participation in society or cost effectiveness. The data clearly show that constructs failing at different rates is associated with the age and gender of the recipients.

Overall, the number of primary hip replacements recorded annually in the registry continues to increase with 1,344,357 eligible for analysis. The COVID-19 pandemic has had a marked impact on the provision of hip replacement with primary THR decreasing from 99,873 in 2019 to 56,596 in 2020 before partially recovering to 84,998 in 2021, and revision THR falling from 8,244 in 2019 to 5,069 in 2020 and 5,580 in 2021. The 2021 rate still represents an under-provision, with significant implications for morbidity among patients. The provision of THR for a fractured neck of femur decreased markedly from 5,648 in 2019 to 4,119 in 2020, but has not increased significantly in 2021, with 4,147 performed. This may be multifactorial with risk assessment of patients undergoing treatment for hip fracture in light of COVID-19, the impact of COVID-19 on the ability to provide interventions and the generation of new evidence, such as the HEALTH trial which was published in 2019.

Since 2003, the types of implants utilised have changed dramatically and these changes continue. Between 2003 and 2007, cemented fixation was the most common, followed by uncemented fixation. Between 2008 and 2019 uncemented fixation was the most common, with hybrid fixation increasing steadily from 2012 to become the most commonly used fixation for the first time in 2020.

Since 2011, the use of ceramic-on-ceramic bearings has declined while the use of ceramic-on-polyethylene bearings has increased markedly, with ceramic-on-polyethylene hybrid total hip replacements being the most utilised construct in 2021 (20.9% of all THRs), followed by uncemented ceramic-on-polyethylene (19.0%) and then cemented metal-on-polyethylene (15.9%). This decline in the use of cemented metal-on-polyethylene hip replacement has continued despite the evidence that this is the most cost-effective option in patients over 70 years of age (Fawsitt et al., 2019).

This is the third year in which we have reported separately on dual mobility; this is used in different bearing combinations and the numbers this year enable us to report on metal-on-polyethylene-on-metal and ceramic-on-polyethylene-on-metal within some sub-groups and their use does seem to be increasing. Given that the proposed benefits of dual mobility bearings include reduced risk of early revision due to dislocation, it is interesting to note that for elective indications, there appears to be a higher risk of early revision. The numbers are not yet sufficient to comment on longer-term risks or the sub-groups described. It is possible that this is a case mix selection effect and our annual report will continue to report on these patterns, particularly if adoption continues to increase. We observed a different pattern when dual mobility is used for patients with a fractured neck of femur in whom we have not observed this early higher rate of revision.

Since the 12th NJR Annual Report in 2015, our data has been presented by age and gender comparing combinations of fixation and bearing. This assists clinicians and patients in choosing classes of prostheses that are the most appropriate for particular patients. For example, in males aged 55 to 64 years, at 15 years post-surgery, hybrid and uncemented ceramic-on-polyethylene and ceramic-on-ceramic constructs as well as cemented ceramic-on-polyethylene constructs have similarly low revision

Fawsitt CG, Thom HHZ, Hunt LP, Nemes S, Blom AW, Welton NJ, Hollingworth W, López-López JA, Beswick AD, Burston A, Rolfson O, Garellick G, Marques EMR; Choice of Prosthetic Implant Combinations in Total Hip Replacement: Cost-Effectiveness Analysis Using UK and Swedish Hip Joint Registries Data. Value Health. 2019 Mar;22(3):303-312.

rates of approximately 5%, while cemented metal-on-polyethylene constructs have revision rates of 8.42% (95% CI 7.66-8.19) and uncemented metal-on-polyethylene bearings 7.52% (95% CI 6.64-8.52). Resurfacings in this group have an even higher revision rate at 15 years of 9.39% (95% CI 8.81-10.00). Females aged 55 to 64 years have lower revision rates than males for all fixation/bearing combinations at 15 years, except for those with metal-on-metal bearings, such as resurfacings, where the revision rates are markedly higher for females than males and markedly higher than alternatives. For example, 15-year revision rates with hybrid ceramic-on-ceramic constructs in this group are 3.13% (95% CI 2.63-3.72) compared to metal-on-metal hip resurfacing of 21.92% (95% CI 20.66-23.24).

For patients over 75 years, all combinations except those with metal-on-metal bearings have good outcomes, with cemented and hybrid ceramic-on-polyethylene possibly having the lowest revision rates. The risk of revision at 18 years in this group is very small, males 5.69% (95% CI 5.02-6.46) and females 4.24% (95% CI 3.67-4.89). The 18-year mortality rate in males aged 75 to 79 years is 89.97% (95% CI 88.85-91.01) and in females aged 75 to 79 years is 83.10% (95% CI 82.12-84.06). This clearly shows that in older patients, the vast majority of treatment strategies will last the rest of the patients' lives. Even in those aged 65 to 69 years at the time of surgery, only 47% of males and 58% of females are still alive 18 years later.

We have also examined outcomes of different head sizes (bearing diameters) with alternative fixation and bearing types and these results are interesting. With metal-on-polyethylene and ceramic-on-polyethylene, large head sizes appear to be associated with higher revision rates particularly with 36mm heads used with cemented fixation and heads >36mm used with uncemented fixation. Ceramic-on-ceramic bearings have lower revision rates with larger bearings when used with uncemented fixation in the short-term, but revision rates begin to rise with the largest head sizes beyond six years. Higher revision rates for 36mm compared to smaller heads are also seen in ceramic-on-ceramic hybrid fixations. This demonstrates the importance of examining the entire construct, not just the individual variables such as fixation, composition of bearing and head size.

With regard to specific branded stem / cup combinations, some of the best implant survivorships have still been found to be achieved by mix and match cemented hard-on-soft bearing constructs, although this practice remains contrary to both the MHRA and implant manufacturers' guidelines for usage.

It is encouraging that the most commonly used constructs by brand in cemented and hybrid fixation have good results. This does not hold true for uncemented fixation, but further breakdown by bearing type for commonly used uncemented implants shows that results are acceptable if metal-on-metal bearings are excluded. It is important to note that there is variability in brand level constructs with variation in revision outcomes according to factors such as the bearing combination used. It is therefore important to consider the construct when selecting implants for specific outcomes. We encourage all readers to view Table 3.H8 for fine details of construct performance.

Metal-on-metal stemmed and resurfacing implants continue to fail at higher than expected rates and their use is now extremely rare. The best performing brand of resurfacing has a revision rate of 11.30% (95% CI 10.76-11.86) at 18 years. The use of metal-on-metal bearings has led to a large excess of revisions which would not have occurred if alternate bearings had been used. This has been modelled and published in the Journal of Bone and Joint Surgery. For every 100 MoM hip-resurfacing procedures, it is estimated that there would be 7.8 excess revisions by ten years, and similarly for every 100 stemmed MoM THR procedures that there would be 15.9, which equates to 8,021 excess first revisions (Hunt et al., 2018).

It is striking to note the high rates of revision for adverse soft tissue reaction to particulate debris in patients who have received metal-on-metal bearings. Analysis of

Hunt LP, Whitehouse MR, Beswick A, Porter ML, Howard P, Blom AW; Implications of Introducing New Technology: Comparative Survivorship Modelling of Metal-on-Metal Hip Replacements and Contemporary Alternatives in the National Joint Registry. J Bone Joint Surg Am. 2018 Feb 7;100(3):189-196.

stemmed metal-on-metal bearings by head size shows that 28mm heads have the best survivorship, but this is still poor compared to alternatives.

We note that revision rates by year of surgery for the entire cohort increased dramatically from 2003 to 2008 and then began to decline and continue to do so. The peak rate matches that for the use of resurfacing hip replacement and stemmed metal-on-metal hip replacements, with the peak usage of these devices in 2008 corresponding with the highest revision rates by year of primary surgery. This demonstrates the profoundly negative effect metal-on-metal has had on hip replacement outcomes. However, as this temporal trend is also present after knee replacement, although with a lesser magnitude, it is likely that other factors also contribute to the decline in revision rates. For example, the decline coincides with the commencement of the NJR's clinician feedback activity. It is noteworthy that this decline appears to be ongoing, which is undoubtedly very good news. Encouragingly the one-year revision rate for hips performed in 2020 continues this trend of a slow decline.

We observed higher revision rates for total hip replacement performed for an indication of a fractured neck of femur compared to osteoarthritis as the only indication. Revision rates were similar for dual mobility compared to conventional bearing total hip replacements in patients undergoing total hip replacement for fractured neck of femur. As expected, mortality rates were higher for the fractured neck of femur group.

The number of revision total hip replacements recorded in the registry increased to a peak of 10,508 in 2012 and since then has declined steadily to 8,244 in 2019, with a marked drop to 5,069 in 2020 and 5,580 in 2021 due to the impact of the COVID-19 pandemic. Please note that there may be late registrations for 2021 procedures and thus the figure for this year may be revised upwards in the next annual report. Aseptic loosening is the most common reason for revision, accounting for nearly half of all cases, followed by pain and instability.

Risk of re-revision rate is strongly associated with time to first revision; 19.59% (95% CI 18.64-20.58) of hips revised within a year of primary surgery are re-revised within ten years. In contrast, when the primary lasts at least five years the re-revision rate is 10.76% (95% CI 10.08-11.50) at ten years. Re-revision rates up to ten years appear to be independent of the fixation and bearing of the primary hip replacement, except for resurfacing procedures which are initially associated with lower re-revision rates, but this pattern appears to wane between seven and ten years after the re-revision.

Overall, this report is good news for patients, clinicians and the healthcare sector. Provision of hip replacement increased up to 2019, revision rates continued to decline and clinicians are increasingly utilising constructs with proven longevity. In contrast, in 2020 there was a massive under-provision of both primary and revision hip replacement with over 47,000 fewer hip replacements performed than in 2019. In 2021, much of this decline was reversed with only 13,000 fewer hip replacements than in 2019. As hip replacement is undertaken to treat severe pain and functional limitation, this deficit represents considerable suffering for a large cohort of people nationally.

With the health service having to address an unprecedented backlog of joint replacement with increasing pressure for cost containment, it is more important than ever that we practice evidence-based medicine and utilise the most effective and cost effective treatments available.

3.3 Outcomes after knee replacement

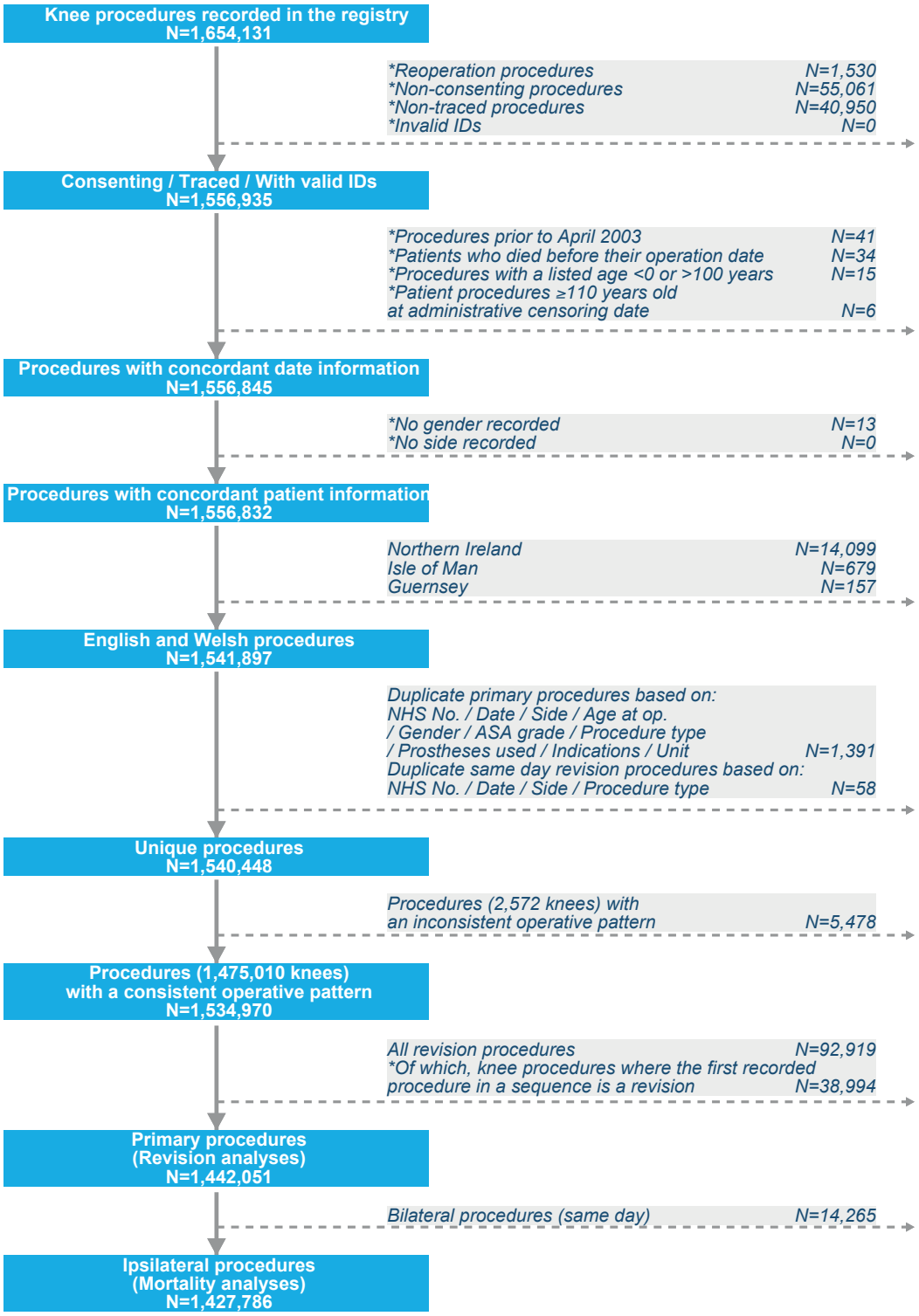
3.3.1 Overview of primary knee replacement surgery

In this section of the report we address revision and mortality outcomes for primary knee operations performed and reported to the registry between 1 April 2003 and 31 December 2021. The very first patients who were entered into the registry therefore had a potential 18.75 years of follow-up.

The outcomes of total and partial knee replacement procedures are discussed throughout this section, hereafter referred to as total (TKR) and unicompartmental (UKR) knee replacement. Brief details of the type of orthopaedic surgery involved for each form of replacement can be found in section 3.1. We note here that the NJR data collection process now distinguishes between medial and lateral unicondylar replacements, although this was not the case in the past. This distinction is available for cases reported on the MDSv7 forms but not in previous versions. Cases are not currently reported separately, but work is ongoing to determine if this distinction can be defined from data entered in previous versions of the MDS forms. If this is possible, it will be reported in future annual reports. The term multicompartmental knee replacement has been introduced to refer to instances when more than one unicompartmental construct is implanted simultaneously i.e. one patellofemoral and one unicondylar, two unicondylar, or one patellofemoral and two unicondylar.

Figure 3.K1 (a) (page 135) describes the data cleaning processes applied to produce the total of 1,442,051 primary knee procedures included in the analyses we present in this section.

Figure 3.K1 (a) Knee cohort flow diagram.



Over the lifetime of the registry, the 1,442,051 primary knee joint replacement procedures contributing to our revision analyses were carried out by a total of 3,521 unique consultant surgeons working across 471 units.

Over the last three years (1 January 2019 to 31 December 2021), 237,924 primary knee procedures (representing 16.5% of the current registry) were performed by 1,839 consultant surgeons working across 406 units. Looking at caseload over this three-year period, the median number of primary procedures per consultant surgeon was 96 (IQR 37 to 179) and the median number of procedures per unit was 525 (IQR 240 to 814). A proportion of surgeons will have commenced practice as a consultant during this period, some may have retired, and some surgeons may have periods of surgical inactivity within the coverage of the NJR, therefore their apparent caseload would be lower.

Over this three-year period, there have been 204,769 primary TKRs performed by 1,827 surgeons (median=86 cases per surgeon; IQR 34 to 157) in 402 separate units (median=526.5 cases per unit; IQR 247 to 814). In the same period, there have been 29,535 primary unicondylar knee procedures performed by 793 consultant surgeons (median=19 cases per surgeon; IQR 6 to 50) in 357 units (median=50 cases per unit; IQR 19 to 115).

The majority of primary knee replacements were carried out on females (females 56.2%; males 43.8%). The median age at primary operation was 70 years (IQR 63 to 76), see Table 3.K3 (page 144) and commentary later for discussion of age at primary by type of knee replacement. Osteoarthritis was given as a documented indication for surgery in 1,404,836 procedures (97.4% of the cohort) and was the sole indication given in 1,393,263 (96.6%) primary knee procedures.

Table 3.K1 (page 137) shows the breakdown of cases by type of knee replacement, the method of fixation, constraint and bearing used. A breakdown within each method of fixation of the percentage of constraint and bearing types used is shown in a separate column. Cemented TKR is the most commonly performed type of knee replacement (83.7% of all primary knee replacements). A further 4.1% were either all uncemented or hybrid TKRs. Most UKRs were unicondylar (9.5% of the total) with the remainder being patellofemoral (1.1%).

More than half of all operations (57.8%) were TKRs which were all cemented and unconstrained (cruciate retaining) with a fixed bearing, followed by 19.8% which were all cemented and posterior stabilised with a fixed bearing. Within each method of fixation, it can be seen that uncemented and hybrid prostheses are mostly unconstrained. While uncemented knees are almost equally likely to have a mobile or fixed bearing, hybrid knees are more likely to utilise a fixed bearing. Approximately two-thirds (69.0%) of cemented TKRs are unconstrained and have a fixed bearing. Unicondylar knee surgery typically involves the use of a mobile bearing (60.0%). Some primary knee replacements could not be classified according to their bearing / constraint (approximately 1.6% of the total cohort).

Table 3.K1 Number and percentage of primary knee replacements by fixation, constraint and bearing.

Fixation, constraint and bearing type	Number of primary knee operations	Percentage of each constraint type used within each method of fixation	Percentage of all primary knee operations
All types	1,442,051		100.0
Total knee replacement			
All cemented	1,206,605		83.7
unconstrained, fixed	832,844	69.0	57.8
unconstrained, mobile	41,741	3.5	2.9
posterior-stabilised, fixed	284,858	23.6	19.8
posterior-stabilised, mobile	13,486	1.1	0.9
constrained condylar	12,225	1.0	0.8
monobloc polyethylene tibia	19,151	1.6	1.3
pre-assembled/hinged/linked	2,300	0.2	0.2
All uncemented	48,781		3.4
unconstrained, fixed	19,115	39.2	1.3
unconstrained, mobile	25,860	53.0	1.8
posterior-stabilised, fixed	3,510	7.2	0.2
other constraints	296	0.6	<0.1
All hybrid	10,116		0.7
unconstrained, fixed	6,593	65.2	0.5
unconstrained, mobile	2,184	21.6	0.2
posterior-stabilised, fixed	923	9.1	0.1
other constraints	416	4.1	<0.1
Unicompartmental knee replacement			
All unicondylar, cemented	103,385		7.2
fixed	46,346	44.8	3.2
mobile	50,506	48.9	3.5
monobloc polyethylene tibia	6,533	6.3	0.5
All unicondylar, uncemented/hybrid	33,508		2.3
fixed	1,421	4.2	0.1
mobile	31,611	94.3	2.2
monobloc polyethylene tibia	476	1.4	<0.1
Patellofemoral	16,476		1.1
Multicompartmental	622		<0.1
Unconfirmed	22,558		1.6

Figure 3.K1 (b) Frequency of primary TKR within elective cases stratified by procedure type, bars stacked by volume per consultant per year.

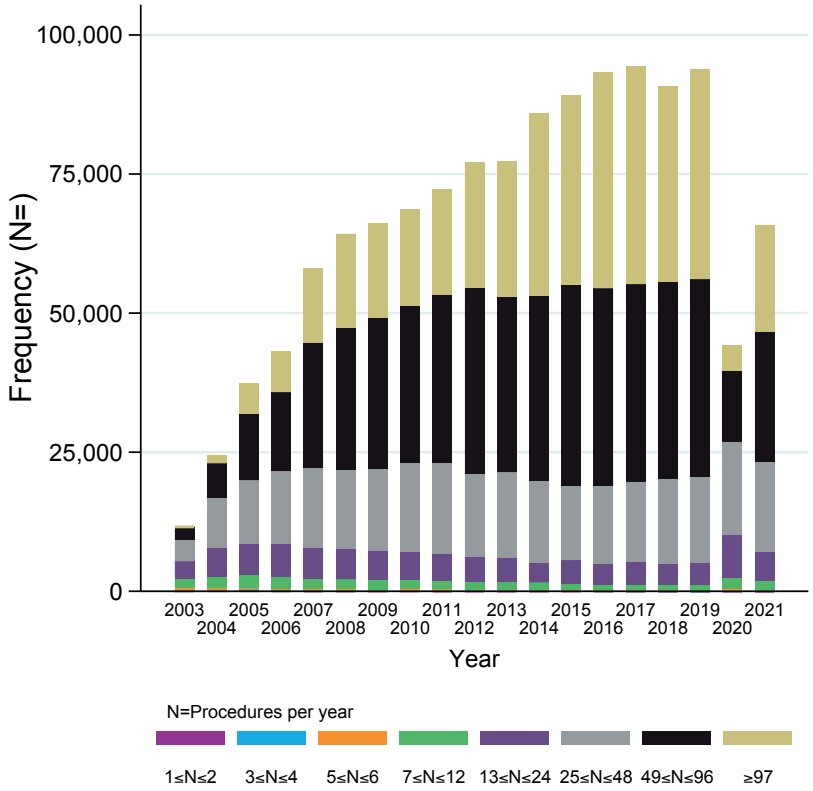


Figure 3.K1 (c) Frequency of primary UKR within elective cases stratified by procedure type, bars stacked by volume per consultant per year.

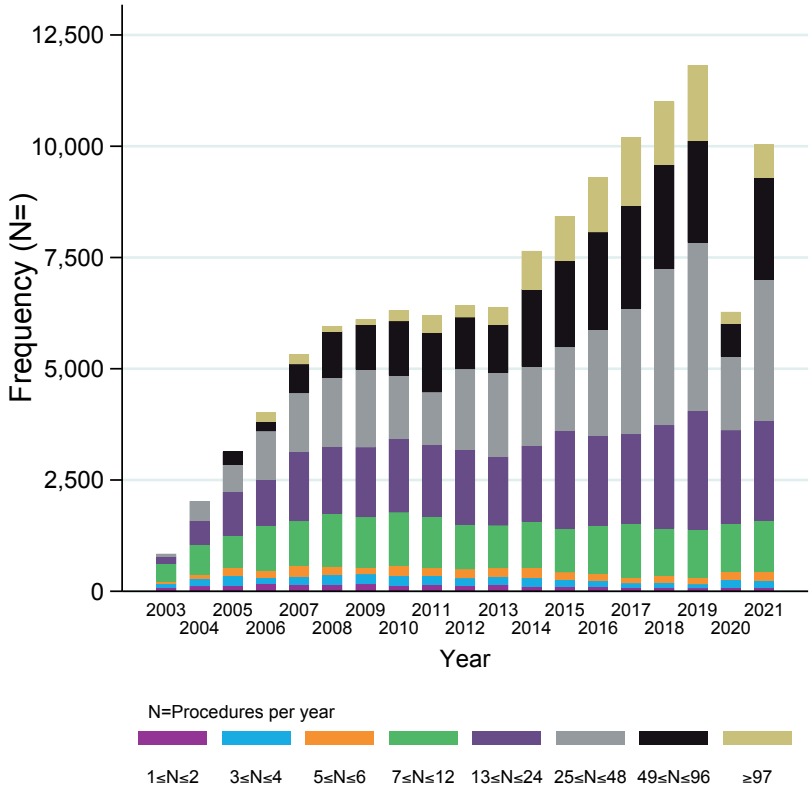
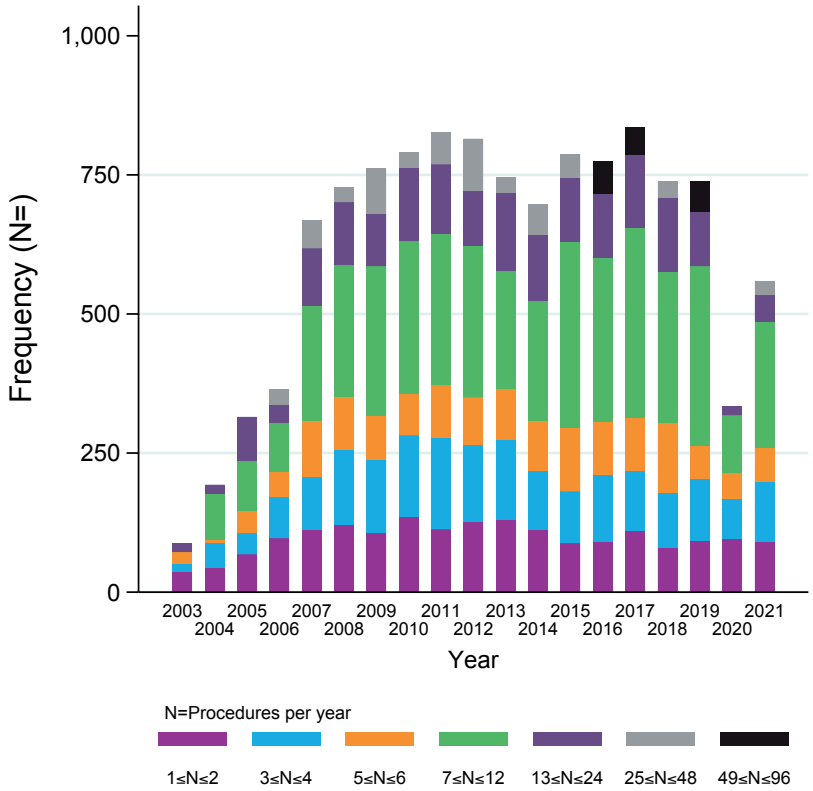


Figure 3.K1 (d) Frequency of primary patellofemoral knee replacements within elective cases stratified by procedure type, bars stacked by volume per consultant per year.



Figures 3.K1 (b) to (d) (pages 138 to 140) show the yearly number of primary knee replacements performed for all indications. Procedures have been stratified by total knee, unicondylar and patellofemoral joint replacements. Please note the difference in scale of the y-axis between each plot.

Each bar in the figure is further stratified by the volume of procedures that the consultant performed in that year within that joint replacement type i.e. if a surgeon performed 25 elective TKR procedures, 25 unicondylar knee replacements and 25 patellofemoral joint replacement procedures, their annual total volume would be 75 procedures. However, each 25 procedures are not aggregated and only contribute to the grey sub-division in each figure respectively.

Figure 3.K1 (b) shows that the volume of TKRs increased from when data collection started until 2020 when the impact of COVID-19 took effect. Prior to 2020 the majority of additional procedures were contributed by higher volume surgeons i.e. those performing 49 or more procedures annually. In 2020, the majority of procedures were performed by those performing 48 or fewer procedures annually before the previous pattern was restored in 2021.

Figure 3.K1 (c) shows that the volume of unicondylar knee replacements increased rapidly from 2014 until the impact of COVID-19 in 2020. The recovery of UKR procedure volumes in 2021 has been better than for TKRs. Prior to 2020 the majority of additional procedures were contributed by higher volume consultants i.e. those performing 25 or more procedures annually. In 2020, the majority of procedures were performed by those performing under 25 procedures annually, before the previous pattern was restored in 2021. Only a small proportion of the procedures were contributed by consultants performing fewer than seven unicondylar knee replacements per year.

Figure 3.K1 (d) shows that the volume of patellofemoral knee replacements was fairly constant from 2007 onwards until the impact of COVID-19 in 2020 and partial recovery in 2021. Prior to 2020 the majority of procedures recorded in the registry were contributed by consultants who performed more than seven procedures annually, this reversed in 2020 before being restored in 2021.

Table 3.K2 Percentage of primary knee replacements by fixation, constraint, bearing and calendar year.

Fixation, constraint and bearing type	2004 n= 42,832	2005 n= 43,516	2006 n= 50,391	2007 n= 67,715	2008 n= 74,691	2009 n= 76,692	2010 n= 79,287	2011 n= 82,886	2012 n= 86,775	2013 n= 86,499	2014 n= 96,311	2015 n= 100,137	2016 n= 105,239	2017 n= 107,192	2018 n= 103,964	2019 n= 107,760	2020 n= 52,334	2021 n= 77,830
Total knee replacement																		
All cemented	**78.2**	**79.2**	**78.8**	**78.8**	**79.3**	**80.2**	**81.6**	**83.2**	**85.7**	**86.8**	**86.7**	**86.6**	**86.4**	**86.0**	**85.4**	**84.9**	**83.2**	**82.9**
Cemented and																		
unconstrained, fixed	52.0	51.6	49.9	49.7	50.7	52.2	53.5	55.9	58.8	59.4	60.5	61.4	62.1	61.6	61.2	61.3	60.2	61.6
unconstrained, mobile	4.2	5.9	6.5	6.4	5.7	4.7	4.0	2.9	2.4	2.1	1.9	1.7	1.7	1.6	1.6	1.5	1.7	1.5
posterior-stabilised, fixed	20.3	19.3	19.6	19.8	20.4	20.8	21.2	21.1	20.8	20.9	20.2	19.9	19.3	19.5	19.1	18.7	18.0	16.1
posterior-stabilised, mobile	1.0	1.7	1.8	1.6	1.4	1.4	1.4	1.2	1.1	1.2	1.0	0.8	0.6	0.4	0.3	0.3	0.4	0.6
constrained condylar	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.5	0.8	1.0	1.2	1.0	1.1	1.3	1.4	1.6	1.8
monobloc polyethylene tibia	0.2	0.3	0.6	0.9	0.8	0.7	1.0	1.6	2.0	2.1	1.9	1.5	1.5	1.6	1.6	1.4	1.1	1.1
pre-assembled/hinged/ linked	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2
All uncemented	**6.3**	**6.0**	**6.3**	**6.3**	**6.0**	**5.5**	**4.6**	**4.0**	**3.2**	**2.5**	**2.5**	**2.3**	**2.0**	**2.0**	**1.9**	**1.9**	**1.8**	**1.8**
Uncemented and																		
unconstrained, fixed	2.4	2.2	2.4	2.7	2.6	2.5	1.7	1.4	1.0	0.7	0.6	0.7	0.8	0.8	0.8	1.0	1.1	1.1
unconstrained, mobile	3.3	3.4	3.4	3.2	3.1	2.6	2.6	2.4	2.0	1.6	1.6	1.4	1.1	1.0	0.8	0.8	0.7	0.7
posterior-stabilised, fixed	0.6	0.4	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.1
other constraints	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
All hybrid	**2.7**	**2.3**	**1.7**	**1.4**	**1.3**	**1.2**	**0.9**	**0.5**	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.2**	**0.3**	**0.3**	**0.3**	**0.2**
Hybrid and																		
unconstrained, fixed	2.3	1.9	1.2	1.0	1.1	0.9	0.7	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
unconstrained, mobile	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.1	0.1	0.1	<0.1	<0.1
posterior-stabilised, fixed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.1
other constraints	<0.1	0.2	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	<0.1

Note: Data from 2003 have been included in 2004 since 2003 was not a complete year. Percentages calculated as percentage of total yearly operations.
Note: A zero represents no procedures of this bearing type.

Table 3.K2 (continued)

Fixation, constraint and bearing type	2004 n= 42,832	2005 n= 43,516	2006 n= 50,391	2007 n= 67,715	2008 n= 74,691	2009 n= 76,692	2010 n= 79,287	2011 n= 82,886	2012 n= 86,775	2013 n= 86,499	2014 n= 96,311	2015 n= 100,137	2016 n= 105,239	2017 n= 107,192	2018 n= 103,964	2019 n= 107,760	2020 n= 52,334	2021 n= 77,830
Unicompartmental knee replacement																		
All unicondylar, cemented	**8.1**	**8.2**	**8.8**	**8.4**	**8.3**	**8.0**	**7.8**	**7.1**	**6.9**	**6.6**	**6.4**	**6.1**	**5.9**	**6.0**	**6.7**	**7.1**	**8.0**	**8.3**
Unicondylar, cemented and																		
fixed	0.9	1.0	1.0	1.0	1.2	1.4	1.8	1.9	2.3	2.7	3.0	3.3	3.6	4.1	5.0	5.7	6.7	7.4
mobile	6.6	6.2	6.6	6.6	6.5	6.0	5.5	4.7	4.1	3.4	3.0	2.5	1.9	1.7	1.4	1.2	1.1	0.7
monobloc polyethylene tibia	0.7	0.9	1.2	0.9	0.7	0.6	0.5	0.4	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.3
All unicondylar, uncemented/hybrid	**0.1**	**0.2**	**0.2**	**0.3**	**0.4**	**0.7**	**0.9**	**1.2**	**1.2**	**1.4**	**2.0**	**2.8**	**3.4**	**3.9**	**4.3**	**4.3**	**5.1**	**5.1**
Unicondylar, uncemented/hybrid and																		
fixed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
mobile	<0.1	0.1	0.1	0.2	0.3	0.6	0.7	1.0	1.1	1.4	1.9	2.7	3.3	3.8	4.1	4.1	4.8	4.9
monobloc polyethylene tibia	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
Patellofemoral	**1.0**	**1.0**	**1.1**	**1.3**	**1.4**	**1.4**	**1.4**	**1.4**	**1.3**	**1.2**	**1.1**	**1.1**	**1.0**	**1.1**	**0.9**	**0.9**	**1.0**	**1.0**
Multicompartmental	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Unconfirmed	**3.6**	**3.1**	**3.1**	**3.5**	**3.1**	**2.9**	**2.7**	**2.5**	**1.2**	**1.0**	**0.8**	**0.7**	**0.8**	**0.7**	**0.6**	**0.5**	**0.6**	**0.6**
All	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Note: Data from 2003 have been included in 2004 since 2003 was not a complete year. Percentages calculated as percentage of total yearly operations.
Note: A zero represents no procedures of this bearing type.

Table 3.K2 (page 141) shows the annual rates for the usage of the different types of primary knee replacements. Overall, more than 90% of all types of primary knee replacement utilised all cemented fixation, and since 2004 the share of all implant replacements of this type has increased by approximately 5%. The main decline in the type of primary knee replacements carried out has been in the use of all uncemented and hybrid TKRs over time (now 2.0% of all knee replacements).

Usage of each implant of this type has decreased proportionally to less than a quarter of those figures reported for 2004 (when they were 9.0% of all knee replacements).

Figure 3.K2 illustrates the temporal changes in fixation, highlighting the dominance of cemented TKR primaries.

Figure 3.K2 Fixation by year of procedure in primary knee replacement.

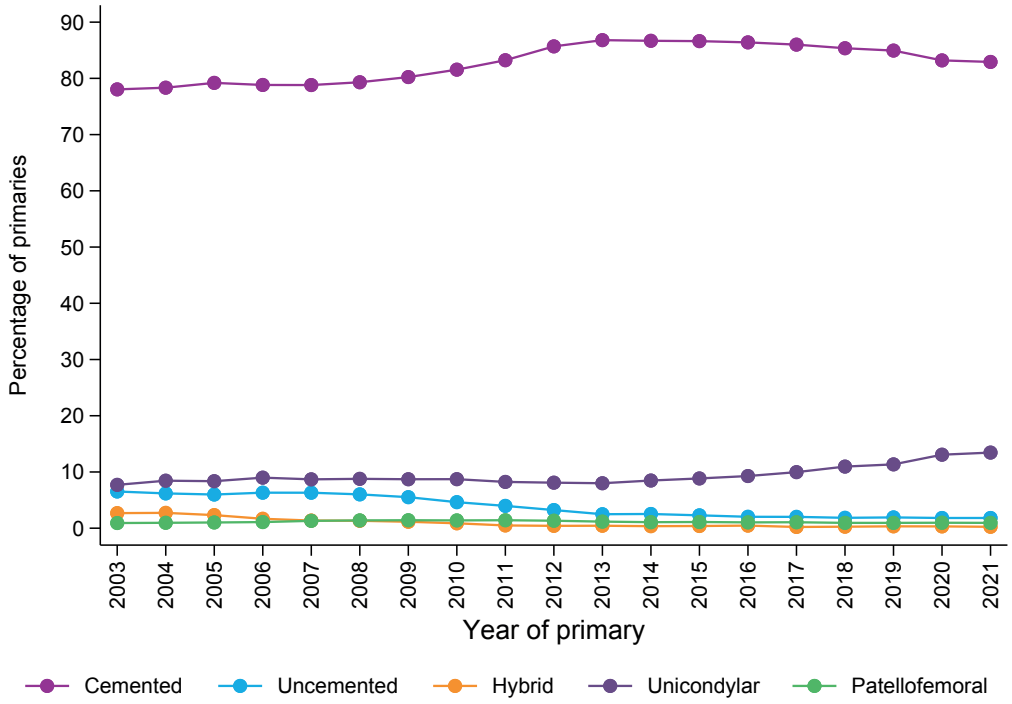


Table 3.K3 Age at primary knee replacement by fixation, constraint and bearing type.

Fixation, constraint and bearing type	N	Age of patient (years)		Male (%)[3]
		Median (IQR)[1]	Mean (SD)[2]	
All types	1,442,051	70 (63 to 76)	68.9 (9.6)	43.6
All cemented	1,206,605	70 (64 to 76)	69.7 (9.3)	42.5
unconstrained, fixed	832,844	70 (64 to 76)	69.6 (9.1)	43.0
unconstrained, mobile	41,741	69 (62 to 76)	68.8 (9.6)	42.1
posterior-stabilised, fixed	284,858	70 (64 to 77)	69.8 (9.4)	41.2
posterior-stabilised, mobile	13,486	67 (60 to 74)	66.5 (10.1)	44.6
constrained condylar	12,225	71 (63 to 78)	69.9 (10.3)	36.4
monobloc polyethylene tibia	19,151	74 (69 to 79)	73.4 (8.3)	40.8
pre-assembled/hinged/linked	2,300	75 (66 to 82)	73.1 (12.5)	27.2
All uncemented	48,781	69 (62 to 75)	68.2 (9.6)	48.7
unconstrained, fixed	19,115	68 (61 to 75)	68.0 (9.8)	50.2
unconstrained, mobile	25,860	69 (62 to 75)	68.5 (9.2)	46.8
posterior-stabilised, fixed	3,510	67 (59 to 74)	66.7 (10.6)	53.0
other constraints	296	67 (60.5 to 73)	66.4 (9.0)	73.6
All hybrid	10,116	69 (62 to 76)	68.7 (9.8)	44.5
unconstrained, fixed	6,593	70 (63 to 76)	69.0 (9.5)	45.4
unconstrained, mobile	2,184	69 (62 to 76)	68.7 (9.8)	38.2
posterior-stabilised, fixed	923	69 (60 to 75)	67.4 (10.5)	46.7
other constraints	416	66 (58.5 to 74.5)	65.8 (10.7)	58.9
All unicondylar, cemented	103,385	64 (57 to 71)	63.9 (9.8)	53.5
fixed	46,346	63 (56 to 71)	63.5 (9.9)	55.5
mobile	50,506	64 (57 to 71)	64.2 (9.5)	51.6
monobloc polyethylene tibia	6,533	64 (57 to 71)	64.0 (10.0)	53.5
All unicondylar, uncemented/hybrid	33,508	65 (58 to 72)	64.8 (9.6)	54.9
fixed	1,421	66 (57 to 74)	65.3 (11.2)	43.8
mobile	31,611	65 (58 to 72)	64.8 (9.5)	55.6
monobloc polyethylene tibia	476	65 (58 to 71)	64.6 (9.4)	42.0
Patellofemoral	16,476	58 (50 to 67)	58.5 (11.7)	22.7
Multicompartmental	622	60 (53 to 68)	60.7 (10.1)	46.9
Unconfirmed	22,558	69 (61 to 76)	68.1 (10.2)	43.8

[1]IQR=Interquartile range - age of middle 50% of patients at time of primary knee operation.
[2]SD=Standard deviation.
[3]The percentage male figures are based on the total number of primary knee replacements.

Table 3.K3 (page 144) shows the age and gender distribution of patients undergoing primary knee replacement. The median age of a person receiving a cemented TKR was 70 years (IQR 64 to 76 years). Patients receiving cemented unicondylar prostheses were typically six years younger (median age 64 years; IQR 57 to 71) compared to all types of knee replacement while those receiving uncemented/hybrid unicondylar prostheses were five years younger (median age 65 years; IQR 58 to 72). The patellofemoral group were typically 12 years younger (median age 58 years; IQR 50 to 67) compared to all types of knee replacement. Those receiving multicompartmental knee replacements were typically ten years younger (median age 60 years; IQR 53 to 68) compared to all types of knee replacement.

Females were more likely to have a primary TKR; they received 57.5%, 51.3% and 55.5% of cemented, uncemented and hybrid type procedures respectively. Conversely, cemented and uncemented/hybrid unicondylar surgery was performed on a higher proportion of males (53.5% and 54.9% respectively). Patellofemoral surgery was predominantly carried out on females (77.3% of patients) who are typically younger than a TKR or unicondylar patient, with a median age at operation of 58.

Table 3.K4 shows the ASA grade and indication for knee replacement by gender for all primary knee replacements. ASA 2 is the most common ASA grade and only a small number of patients with a grade greater than ASA 3 undergo knee replacement. The majority of cases are performed with osteoarthritis as the sole indication; 1,393,263 (96.6%) of all 1,442,051 knee replacements.

Table 3.K4 Primary knee replacement patient demographics.

	Male N (%)		Female N (%)		All N (%)	
Total		**628,145**		**813,906**		**1,442,051**
ASA 1		82,050 (13.1)		80,715 (9.9)		162,765 (11.3)
ASA 2		442,436 (70.4)		595,820 (73.2)		1,038,256 (72.0)
ASA 3		101,418 (16.1)		134,881 (16.6)		236,299 (16.4)
ASA 4		2,180 (0.3)		2,409 (0.3)		4,589 (0.3)
ASA 5		61 (<0.1)		81 (<0.1)		142 (<0.1)
Osteoarthritis as a reason for primary		616,628 (98.2)		788,208 (96.8)		1,404,836 (97.4)
Osteoarthritis as the sole reason for primary		611,465 (97.3)		781,798 (96.1)		1,393,263 (96.6)
Age	Mean (SD) 68.7 (9.3)	Median (IQR) 69 (62 to 75)	Mean (SD) 69.2 (9.8)	Median (IQR) 70 (63 to 76)	Mean (SD) 68.9 (9.6)	Median (IQR) 70 (63 to 76)

Note: Percentages in this table are calculated by column.

3.3.2 First revision after primary knee replacement surgery

In this section, estimates of cumulative revision in the tables are presented at 1, 3, 5, 10, 15 and 18 years. A total of 43,838 first revisions of a knee prosthesis have been linked to registry primary knee replacement surgery records of operations undertaken between 2003 and 2021. Figures 3.K3 (a) and (b) illustrate temporal changes in the overall revision rates using Kaplan-Meier estimates; procedures have been grouped by the year of the primary operation.

Figure 3.K3 (a) (page 147) plots each Kaplan-Meier curve with a common origin, i.e. time zero is equal to the year of operation. This illustrates that there was a small increase in revision estimates up until 2008, followed by a small decline.

Figure 3.K3 (b) (page 148) shows the same curves plotted against calendar time, where the origin of each curve is the year of operation. It separates each year enabling changes in revision estimates to be clearly identified. In addition, the revision rates at 1, 3, 5, 7, 10, 13, 15 and 17 years have been highlighted. If revision rates and timing of revision rates were static across time, it would be expected that all revision curves would be the same shape and equally spaced; a departure from this indicates a change in the number and timing of revision procedures. The cumulative probability of a knee joint being revised at three and five years increased for each operative year group between 2003 and 2008; the probability of being revised at three and five years reduced for operations performed between 2009 and 2021. From the peak in 2008, the yearly survivorship curves are less divergent, i.e. a slowing in the observed trend.

Possible reasons for a peak in the probability of revision in the 2008 cohort out to ten years are: 1) the registry was not capturing the full range and number of operations taking place in units in England and Wales until 2008, and 2) there could be bias in terms of the general overall health, risk of revision, and other key characteristics of the patients on record in the registry in the early years. Given that similar, more marked, patterns are observed in primary hip replacements and that the start of the reduction coincides with the timeline of when NJR clinician feedback and performance analyses were introduced, it is likely that these patterns represent improved survival as a result of clinician feedback and the improved adoption of evidence-based practice.

Figure 3.K3 (a) KM estimates of cumulative revision by year, in primary knee replacements.

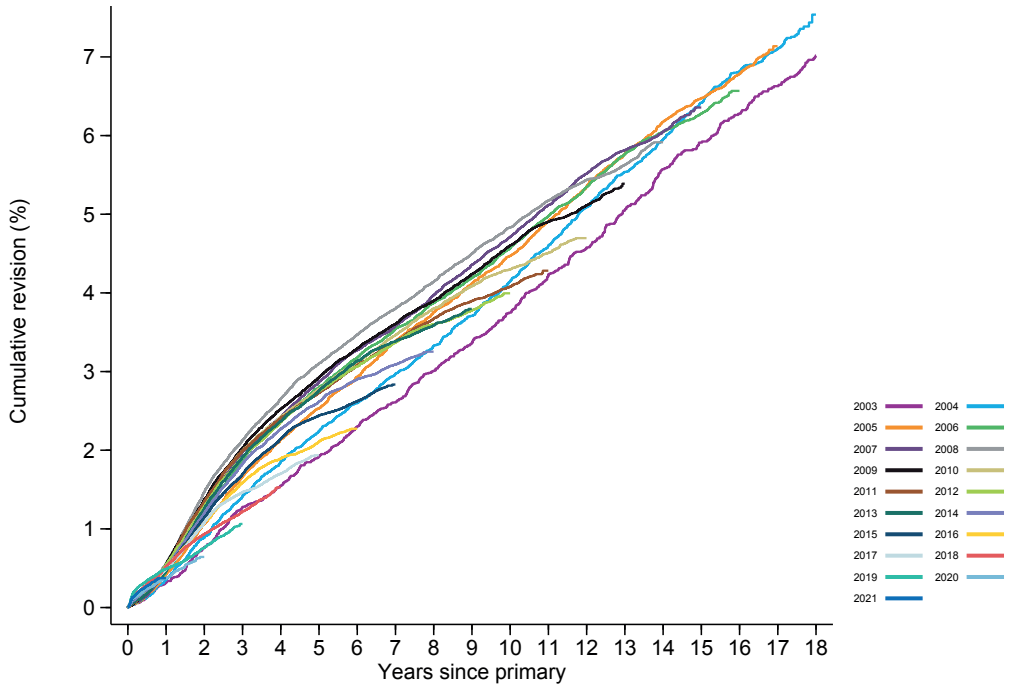


Figure 3.K3 (b) KM estimates of cumulative revision by year, in primary knee replacements plotted by year of primary.

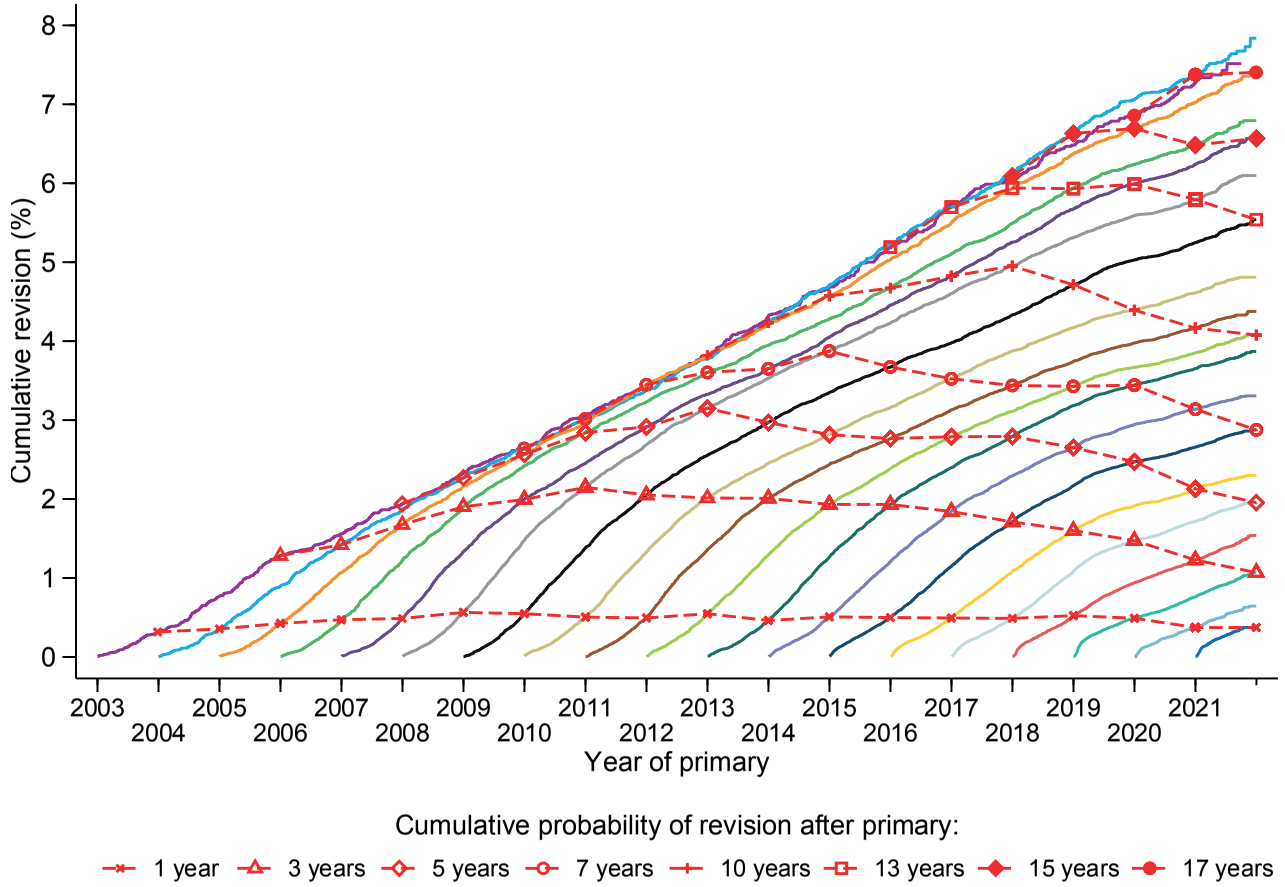


Table 3.K5 KM estimates of cumulative revision (95% CI) by fixation, constraint and bearing, in primary knee replacements. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Fixation, constraint and bearing type	N	Time since primary					
		1 year	3 years	5 years	10 years	15 years	18 years
All types	1,442,051	0.49 (0.48-0.51)	1.71 (1.68-1.73)	2.48 (2.45-2.50)	4.01 (3.97-4.05)	5.66 (5.58-5.73)	6.74 (6.57-6.91)
Unconfirmed	22,558	0.71 (0.61-0.83)	2.19 (2.00-2.40)	3.10 (2.88-3.35)	5.22 (4.90-5.56)	7.20 (6.72-7.71)	*8.35 (7.60-9.18)*
All cemented	1,206,605	0.42 (0.41-0.43)	1.44 (1.42-1.46)	2.07 (2.04-2.09)	3.15 (3.11-3.19)	4.26 (4.19-4.33)	5.08 (4.91-5.26)
unconstrained, fixed	832,844	0.38 (0.37-0.40)	1.33 (1.30-1.36)	1.88 (1.85-1.91)	2.83 (2.78-2.87)	3.93 (3.84-4.01)	4.83 (4.61-5.05)
unconstrained, mobile	41,741	0.51 (0.45-0.59)	1.78 (1.65-1.92)	2.64 (2.48-2.81)	4.04 (3.83-4.26)	5.17 (4.88-5.48)	*5.53 (5.05-6.06)*
posterior-stabilised, fixed	284,858	0.48 (0.45-0.50)	1.65 (1.60-1.70)	2.44 (2.38-2.50)	3.83 (3.74-3.92)	4.98 (4.84-5.13)	5.77 (5.40-6.16)
posterior-stabilised, mobile	13,486	0.63 (0.51-0.78)	2.08 (1.84-2.34)	2.82 (2.55-3.13)	4.14 (3.78-4.54)	5.29 (4.77-5.86)	*5.42 (4.85-6.05)*
constrained condylar	12,225	0.97 (0.80-1.16)	2.10 (1.84-2.40)	2.76 (2.44-3.13)	3.93 (3.36-4.60)	*5.24 (4.02-6.83)*	
monobloc polyethylene tibia	19,151	0.35 (0.28-0.45)	1.24 (1.08-1.41)	1.68 (1.49-1.89)	2.18 (1.94-2.45)	2.53 (2.18-2.94)	*2.53 (2.18-2.94)*
pre-assembled/hinged/linked	2,300	2.07 (1.54-2.77)	4.28 (3.47-5.29)	5.95 (4.92-7.18)	8.72 (7.09-10.70)	*10.05 (7.95-12.66)*	
All uncemented	48,781	0.56 (0.49-0.63)	2.05 (1.93-2.19)	2.78 (2.63-2.94)	3.95 (3.76-4.15)	5.23 (4.96-5.52)	6.19 (5.63-6.79)
unconstrained, fixed	19,115	0.63 (0.52-0.75)	2.25 (2.04-2.48)	2.91 (2.67-3.18)	4.10 (3.79-4.44)	5.28 (4.86-5.73)	*5.80 (5.13-6.56)*
unconstrained, mobile	25,860	0.49 (0.41-0.58)	1.88 (1.72-2.06)	2.63 (2.43-2.84)	3.67 (3.42-3.93)	4.90 (4.54-5.30)	*5.64 (4.97-6.39)*
posterior-stabilised, fixed	3,510	0.64 (0.42-0.96)	2.27 (1.82-2.83)	3.25 (2.69-3.93)	5.44 (4.61-6.40)	7.62 (6.42-9.04)	*12.18 (8.55-17.20)*
other constraints	296	0.68 (0.17-2.69)	*2.14 (0.97-4.71)*	*2.54 (1.22-5.26)*	*2.98 (1.50-5.88)*		
All hybrid	10,116	0.52 (0.40-0.69)	1.69 (1.45-1.97)	2.33 (2.04-2.66)	3.51 (3.13-3.93)	4.36 (3.89-4.89)	*4.87 (4.23-5.62)*
unconstrained, fixed	6,593	0.46 (0.32-0.66)	1.59 (1.31-1.93)	2.19 (1.86-2.59)	3.20 (2.77-3.69)	3.99 (3.47-4.59)	*4.20 (3.61-4.88)*
unconstrained, mobile	2,184	0.92 (0.60-1.43)	1.83 (1.34-2.49)	2.37 (1.79-3.13)	3.85 (2.94-5.02)	*5.71 (4.13-7.86)*	*6.83 (4.49-10.32)*
posterior-stabilised, fixed	923	0	1.94 (1.15-3.27)	3.39 (2.20-5.20)	5.42 (3.74-7.82)	*5.80 (4.01-8.34)*	
other constraints	416	0.48 (0.12-1.92)	2.20 (1.15-4.19)	2.95 (1.69-5.13)	*4.85 (3.07-7.64)*	*5.39 (3.42-8.46)*	
All unicondylar, cemented	103,385	0.95 (0.89-1.01)	3.58 (3.46-3.70)	5.41 (5.26-5.56)	10.03 (9.80-10.27)	15.17 (14.78-15.58)	17.90 (17.11-18.73)
fixed	46,346	0.62 (0.55-0.69)	2.48 (2.32-2.64)	3.77 (3.56-3.98)	7.17 (6.77-7.58)	10.92 (10.09-11.81)	*12.98 (11.15-15.07)*
mobile	50,506	1.26 (1.17-1.36)	4.34 (4.16-4.52)	6.42 (6.21-6.65)	11.47 (11.17-11.79)	16.90 (16.42-17.40)	19.80 (18.88-20.77)
monobloc polyethylene tibia	6,533	0.72 (0.54-0.96)	4.31 (3.83-4.84)	6.44 (5.84-7.09)	10.69 (9.86-11.58)	14.97 (13.78-16.25)	*16.47 (14.91-18.17)*
All unicondylar, uncemented/hybrid	33,508	1.18 (1.07-1.31)	2.59 (2.41-2.78)	3.71 (3.48-3.96)	7.37 (6.81-7.97)	*11.51 (9.96-13.27)*	
fixed	1,421	0.22 (0.07-0.68)	2.44 (1.69-3.52)	5.31 (4.02-7.00)	9.52 (7.44-12.15)	*12.96 (9.95-16.78)*	
mobile	31,611	1.24 (1.12-1.37)	2.60 (2.41-2.79)	3.61 (3.37-3.86)	7.20 (6.60-7.86)	*11.70 (9.67-14.13)*	
monobloc polyethylene tibia	476	0.42 (0.11-1.67)	2.56 (1.46-4.47)	4.33 (2.82-6.64)	8.58 (6.24-11.73)	*12.13 (8.49-17.18)*	
Patellofemoral	16,476	1.04 (0.89-1.21)	5.56 (5.20-5.93)	9.21 (8.74-9.70)	17.52 (16.80-18.28)	24.40 (23.22-25.63)	*27.66 (25.55-29.91)*
Multicompartmental	622	1.00 (0.45-2.22)	7.09 (5.27-9.51)	9.77 (7.58-12.54)	*13.39 (10.66-16.75)*		

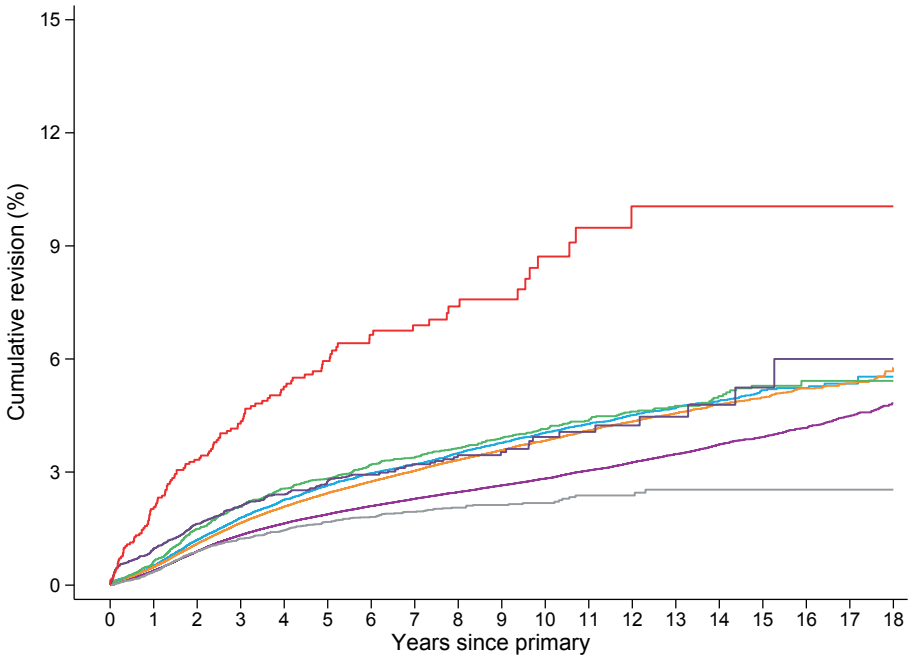
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K5 (page 149) shows Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any cause, for the cohort of all primary knee replacements. This is broken down for TKR by knee fixation type (cemented, uncemented or hybrid) and sub-divided further within each fixation type by the constraint (unconstrained, posterior-stabilised, constrained condylar and highly constrained implants) and bearing mobility (fixed or mobile) and for UKR, by fixation type and bearing mobility (fixed or mobile). The table shows updated estimates at 1, 3, 5, 10, 15 and 18 years from the primary operation together with 95% Confidence Intervals (95% CI).

Where groups have fewer than 250 cases remaining at risk, the figures are shown in blue italics. Further revisions in these groups would be highly unlikely, and when they do occur, they may appear to have a disproportionate impact on the Kaplan-Meier estimate, i.e. the step upwards may seem disproportionately large. Furthermore, the upper 95% CI at these time points may be underestimated. Although a number of statistical methods have been proposed to deal with this, they typically give different values and, as yet, there is no clear consensus for the large datasets presented here. Kaplan-Meier estimates are not shown at all when the numbers at risk fell below ten.

Figures 3.K4 (a) to 3.K4 (d) illustrate the differences in revision rates between the types of knee replacement, fixation and constraint. It is worth noting the different vertical scales between the four figures. The results show the lowest revision rates for cemented unconstrained fixed bearing TKRs and cemented TKRs with monobloc polyethylene tibias. The revision rates in cemented TKRs that are posterior-stabilised and those that have mobile bearings remain higher. The revision rates for UKRs remain substantially higher than for TKRs, this is most marked in the patellofemoral replacement and multicompartmental groups.

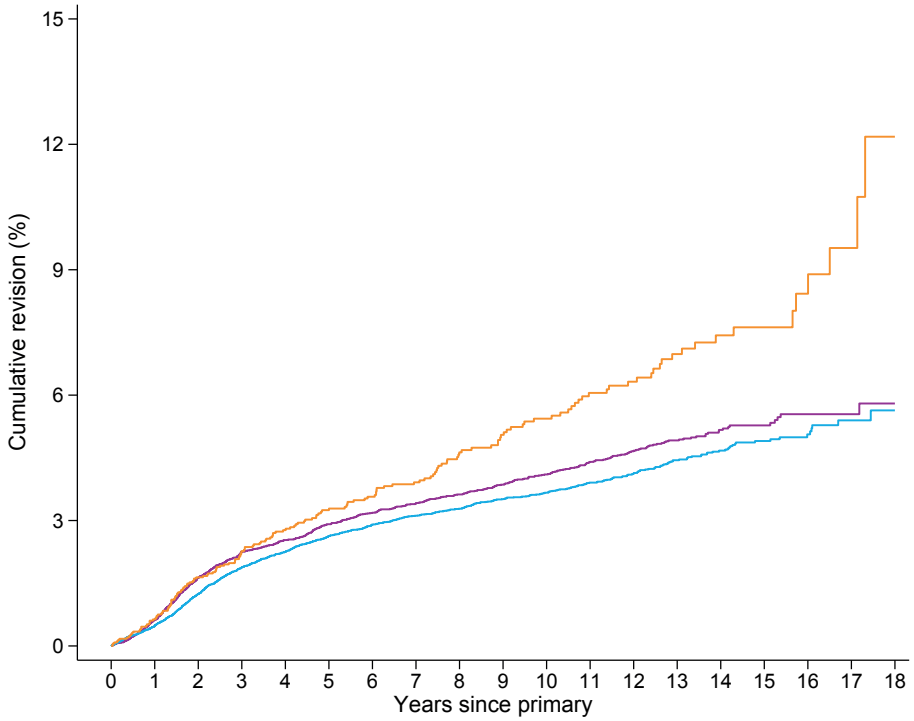
Figure 3.K4 (a) KM estimates of cumulative revision in primary total cemented knee replacements by constraint and bearing. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

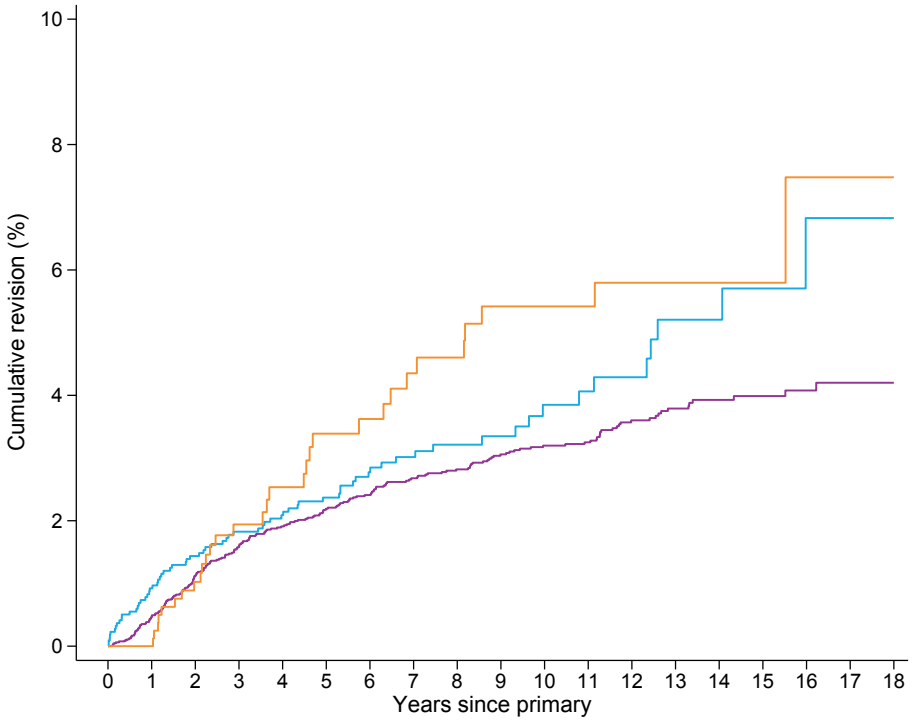
	Numbers at risk									
Unconstrained, fixed	832,844	729,622	575,859	425,928	295,959	191,896	112,202	54,055	19,195	2,517
Unconstrained, mobile	41,741	38,334	33,425	28,436	23,632	18,653	12,885	6,568	1,989	*179*
Posterior-stabilised, fixed	284,858	253,437	203,491	154,265	110,194	73,273	43,117	20,405	7,174	981
Posterior-stabilised, mobile	13,486	12,398	11,256	9,783	7,806	5,650	3,662	2,013	665	*71*
Constrained condylar	12,225	9,445	6,219	3,791	1,754	799	437	*238*	*93*	*8*
Monobloc polyethylene tibia	19,151	17,021	13,187	9,370	5,940	2,899	1,338	565	*130*	*20*
Pre-assembled/hinged/linked	2,300	1,733	1,220	837	500	294	*158*	*74*	*22*	*<4*

Figure 3.K4 (b) KM estimates of cumulative revision in primary total uncemented knee replacements by constraint and bearing. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
Unconstrained, fixed	19,115	17,075	14,494	12,171	10,328	8,328	5,750	2,823	917	*137*
Unconstrained, mobile	25,860	24,144	21,488	18,316	14,602	10,954	7,156	3,765	1,347	*179*
Posterior-stabilised, fixed	3,510	3,259	2,770	2,301	1,737	1,329	966	529	*198*	*28*

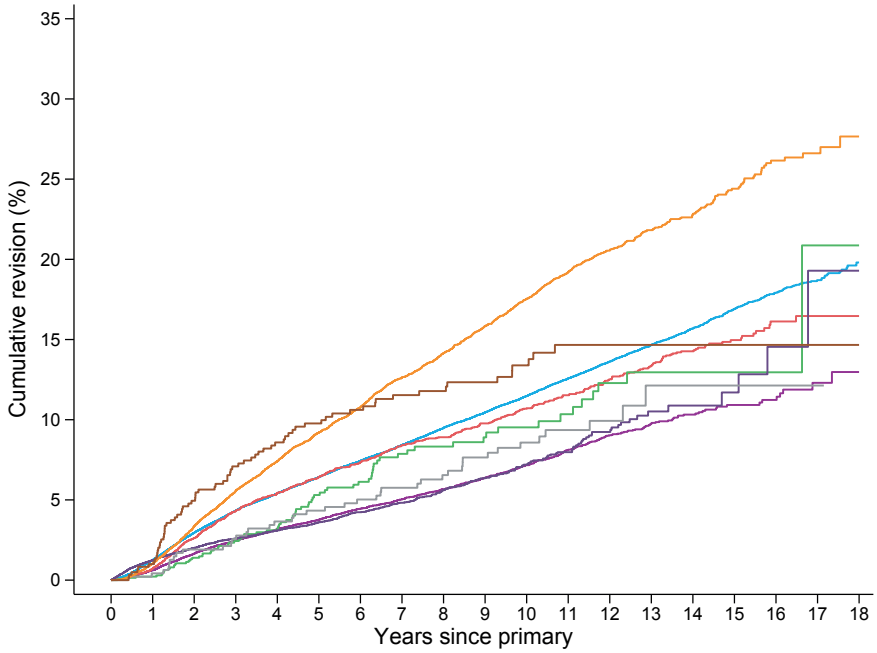
Figure 3.K4 (c) KM estimates of cumulative revision in primary total hybrid knee replacements by constraint and bearing. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk									
Unconstrained, fixed	6,593	6,222	5,695	5,182	4,646	3,967	2,952	1,716	882	*123*
Unconstrained, mobile	2,184	2,074	1,809	1,307	822	536	357	*195*	*83*	*13*
Posterior-stabilised, fixed	923	710	473	403	356	297	*207*	*117*	*39*	*7*

Figure 3.K4 (d) KM estimates of cumulative revision in primary unicondylar or patellofemoral knee replacements by fixation, constraint and bearing. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

Numbers at risk

Cemented, fixed	46,346	36,071	24,108	15,718	9,626	5,478	2,775	1,256	440	*56*
Cemented, mobile	50,506	47,423	42,793	37,219	30,454	23,236	15,475	7,924	2,861	379
Cemented, monobloc polyethylene tibia	6,533	5,990	5,190	4,360	3,578	2,715	1,946	1,149	358	*28*
Uncemented/hybrid, fixed	1,421	1,130	765	514	354	252	*156*	*60*	*22*	*<4*
Uncemented/hybrid, mobile	31,611	24,458	15,513	8,027	3,734	1,808	643	*169*	*38*	*<4*
Uncemented/hybrid, monobloc polyethylene tibia	476	457	436	401	344	263	*120*	*34*	*8*	
Patellofemoral	16,476	14,564	11,858	9,205	6,840	4,664	2,795	1,308	441	*62*
Multicompartmental	622	546	475	399	324	*224*	*71*	*21*	*6*	*<4*

Figure 3.K5 (a) KM estimates of cumulative revision in primary total knee replacements by gender and age.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.

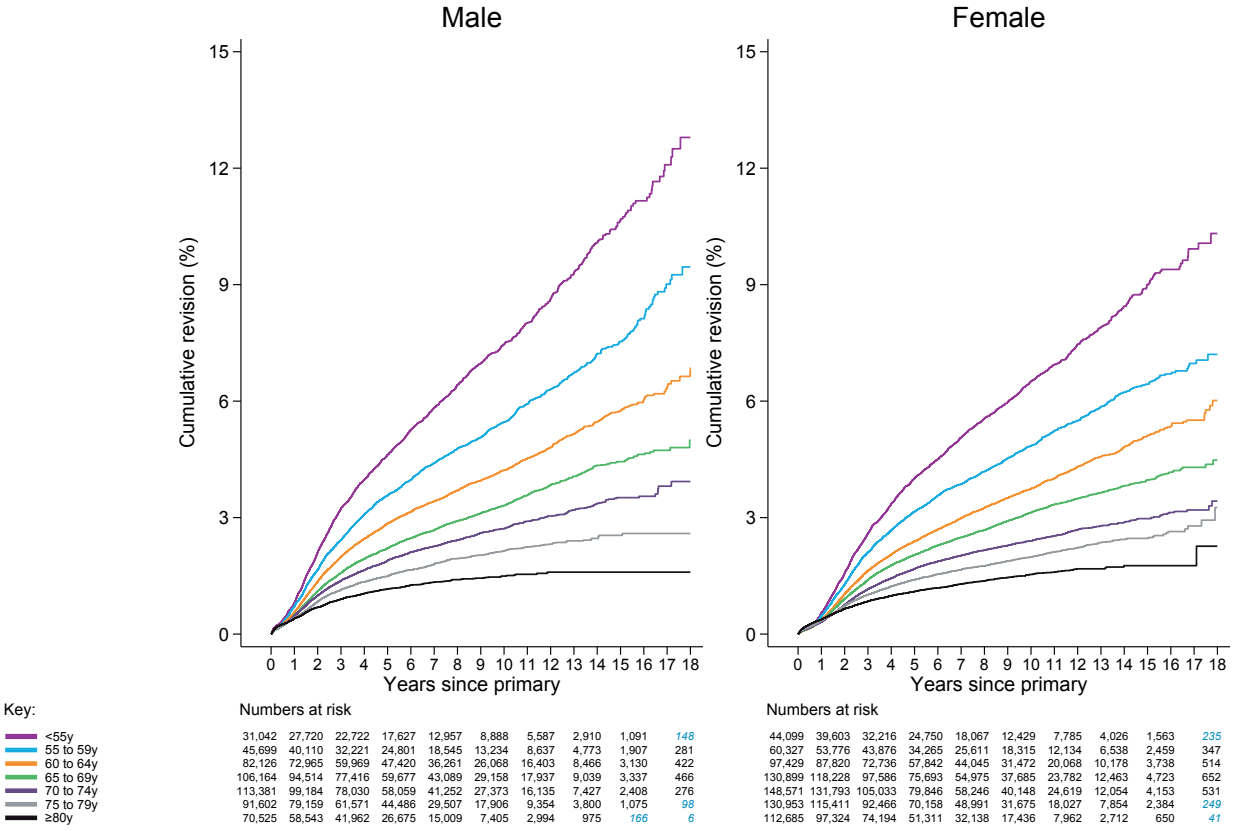
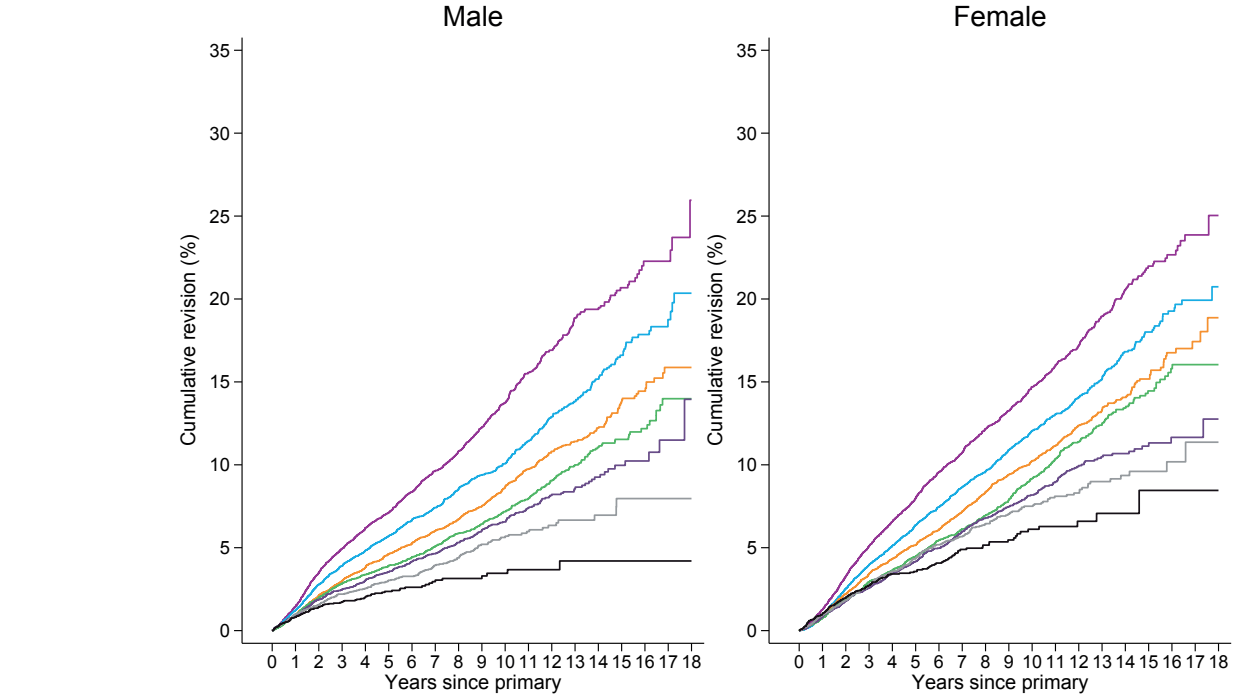


Figure 3.K5 (a) shows that the chance of revision after primary TKR is far higher in younger patient cohorts and that males were slightly more likely, overall, to have a first revision compared to females of comparable grouped age, if they were under the age of 70 when they underwent primary surgery.

Figure 3.K5 (b) KM estimates of cumulative revision in primary unicondylar knee replacements by gender and age. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

Numbers at risk

<55y	11,169	9,638	7,584	5,700	4,104	2,814	1,675	794	271	*31*
55 to 59y	11,573	9,673	7,384	5,500	4,045	2,912	1,917	1,042	393	*56*
60 to 64y	14,557	12,340	9,687	7,529	5,737	4,176	2,700	1,392	475	*58*
65 to 69y	13,966	11,939	9,388	7,049	5,045	3,455	2,157	1,108	409	*67*
70 to 74y	11,200	9,223	6,752	4,776	3,353	2,301	1,375	628	*193*	*19*
75 to 79y	7,004	5,659	4,124	2,923	1,933	1,215	648	294	*88*	*13*
≥80y	4,223	3,328	2,161	1,349	833	463	*206*	*63*	*20*	*<4*

Numbers at risk

<55y	12,530	10,865	8,513	6,399	4,570	3,168	1,967	955	319	*33*
55 to 59y	10,348	8,778	6,887	5,248	3,981	2,929	1,980	1,096	431	*55*
60 to 64y	10,934	9,445	7,529	5,926	4,545	3,355	2,183	1,076	372	*58*
65 to 69y	10,577	9,053	7,218	5,452	4,024	2,852	1,804	921	349	*34*
70 to 74y	9,127	7,661	5,737	4,141	2,973	2,128	1,359	708	257	*30*
75 to 79y	5,948	4,865	3,645	2,701	1,946	1,364	856	400	*127*	*11*
≥80y	3,737	3,062	2,196	1,546	1,001	620	288	*115*	*23*	*<4*

Figure 3.K5 (b) shows that the risk of revision of primary unicondylar knee replacement is, again, substantially higher for younger patient cohorts, but that there are less marked differences in younger patients in the risk of revision according to gender. The risk of revision is higher in all age groups than it is for TKR. Please note the differences in the vertical axes between Figures 3.K5 (a) and (b).

Table 3.K6 (page 157) shows gender and age stratified Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any cause, firstly for all cases combined, then by knee fixation / constraint / bearing sub-divisions. Estimates are shown, along with 95% CIs, for males and females within each of four age bands, <55, 55 to 64, 65 to 74 and ≥75 years for revision rate at 1, 3, 5, 10, 15 and 18 years after the primary operation.

Table 3.K6 KM estimates of cumulative revision (95% CI) by gender, age, fixation, constraint and bearing, in primary knee replacements.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Fixation, constraint and bearing type	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
All cases	<55	44,410	1.02 (0.93-1.12)	3.87 (3.68-4.06)	5.54 (5.32-5.78)	9.51 (9.17-9.86)	13.71 (13.14-14.30)	*16.37 (15.10-17.74)*	63,244	0.73 (0.66-0.80)	3.42 (3.27-3.57)	5.36 (5.17-5.55)	9.31 (9.02-9.60)	13.22 (12.73-13.71)	15.19 (14.30-16.12)
Unconfirmed	<55	921	1.86 (1.16-2.98)	5.17 (3.90-6.85)	7.36 (5.79-9.33)	12.82 (10.60-15.46)	*15.67 (13.02-18.82)*	*18.09 (14.19-22.89)*	1,228	1.48 (0.93-2.34)	4.68 (3.62-6.04)	7.81 (6.41-9.51)	12.05 (10.21-14.18)	*17.04 (14.33-20.20)*	*18.00 (14.83-21.76)*
All cemented	<55	28,689	0.80 (0.70-0.91)	3.19 (2.99-3.41)	4.55 (4.30-4.82)	7.39 (7.02-7.78)	10.66 (10.01-11.36)	*13.16 (11.78-14.69)*	41,582	0.53 (0.46-0.61)	2.54 (2.38-2.70)	3.95 (3.75-4.16)	6.46 (6.17-6.77)	8.93 (8.43-9.46)	*10.29 (9.34-11.33)*
unconstrained, fixed	<55	19,013	0.78 (0.66-0.92)	2.93 (2.69-3.19)	4.05 (3.76-4.36)	6.60 (6.16-7.07)	9.80 (8.96-10.70)	*13.18 (11.36-15.27)*	28,011	0.45 (0.38-0.54)	2.19 (2.02-2.38)	3.54 (3.31-3.79)	5.75 (5.41-6.12)	8.41 (7.78-9.08)	*9.77 (8.53-11.18)*
unconstrained, mobile	<55	1,397	1.01 (0.60-1.71)	4.01 (3.08-5.20)	5.86 (4.71-7.27)	8.18 (6.76-9.87)	*12.11 (9.87-14.81)*	*12.11 (9.87-14.81)*	1,775	0.74 (0.43-1.27)	2.91 (2.21-3.82)	4.77 (3.84-5.92)	7.29 (6.06-8.75)	*9.49 (7.65-11.75)*	*12.65 (8.10-19.47)*
posterior-stabilised, fixed	<55	6,901	0.68 (0.51-0.91)	3.48 (3.06-3.96)	5.40 (4.86-6.01)	9.20 (8.37-10.11)	12.84 (11.47-14.37)	*14.73 (11.64-18.54)*	10,018	0.61 (0.48-0.79)	3.18 (2.85-3.56)	4.70 (4.27-5.16)	8.12 (7.46-8.83)	10.42 (9.41-11.53)	*11.71 (10.04-13.64)*
posterior-stabilised, mobile	<55	739	1.23 (0.64-2.36)	4.09 (2.86-5.84)	5.46 (4.00-7.42)	8.15 (6.27-10.56)	*10.03 (7.54-13.28)*		821	1.26 (0.68-2.33)	4.49 (3.24-6.20)	5.82 (4.38-7.72)	8.09 (6.31-10.34)	*9.39 (7.18-12.24)*	
constrained condylar	<55	381	2.19 (1.10-4.33)	5.02 (3.14-7.97)	*5.92 (3.79-9.20)*	*7.94 (5.14-12.18)*	*7.94 (5.14-12.18)*		557	0.39 (0.10-1.55)	2.30 (1.28-4.13)	2.99 (1.72-5.16)	*4.28 (2.12-8.55)*	*7.10 (2.94-16.58)*	
monobloc polyethylene tibia	<55	183	*0.58 (0.08-4.03)*	*4.24 (2.04-8.69)*	*4.24 (2.04-8.69)*	*6.11 (3.17-11.59)*	*6.11 (3.17-11.59)*		297	1.04 (0.34-3.18)	*3.31 (1.73-6.27)*	*4.75 (2.71-8.26)*	*4.75 (2.71-8.26)*	*7.57 (4.08-13.84)*	
pre-assembled/hinged/ linked	<55	75	*2.74 (0.69-10.52)*	*5.54 (2.12-14.09)*	*9.28 (4.23-19.71)*	*13.29 (6.78-25.13)*			103	*4.01 (1.52-10.34)*	*8.36 (4.26-16.05)*	*10.84 (5.96-19.28)*	*17.21 (7.70-35.94)*		
All uncemented	<55	1,982	0.67 (0.39-1.15)	3.72 (2.95-4.69)	5.33 (4.38-6.48)	8.33 (7.04-9.84)	*11.11 (9.36-13.16)*	*11.70 (9.68-14.11)*	2,056	0.69 (0.41-1.17)	3.59 (2.85-4.52)	5.18 (4.26-6.29)	7.55 (6.37-8.93)	*10.47 (8.77-12.47)*	*12.07 (9.69-14.98)*
unconstrained, fixed	<55	865	0.84 (0.40-1.75)	3.92 (2.77-5.53)	5.32 (3.92-7.20)	7.84 (6.00-10.20)	*10.80 (8.33-13.95)*		849	0.97 (0.49-1.93)	2.90 (1.94-4.33)	3.88 (2.70-5.55)	6.75 (5.00-9.08)	*10.02 (7.38-13.53)*	
unconstrained, mobile	<55	861	0.71 (0.32-1.58)	3.78 (2.67-5.33)	5.50 (4.12-7.32)	8.76 (6.87-11.12)	*11.10 (8.59-14.30)*	*11.10 (8.59-14.30)*	1,002	0.60 (0.27-1.34)	3.71 (2.69-5.10)	5.60 (4.30-7.27)	7.51 (5.94-9.47)	*10.23 (8.05-12.95)*	
posterior-stabilised, fixed	<55	231	*0.00 (.-.)*	*2.71 (1.23-5.93)*	*4.30 (2.25-8.11)*	*8.25 (4.86-13.82)*	*12.00 (7.28-19.44)*		199	*0.00 (.-.)*	*5.80 (3.26-10.24)*	*8.14 (4.98-13.15)*	*11.17 (7.21-17.08)*	*13.50 (8.27-21.64)*	
other constraints	<55	25		*4.35 (0.62-27.07)*	*9.66 (2.48-33.69)*				6						
All hybrid	<55	371	0.54 (0.14-2.15)	3.31 (1.89-5.75)	5.69 (3.71-8.69)	*8.04 (5.57-11.53)*	*10.76 (7.61-15.12)*		461	0.66 (0.21-2.02)	2.71 (1.55-4.73)	4.61 (3.00-7.06)	7.06 (4.95-10.03)	*8.49 (5.98-11.99)*	*8.49 (5.98-11.99)*
unconstrained, fixed	<55	211	*0.48 (0.07-3.33)*	*2.90 (1.31-6.35)*	*5.47 (3.06-9.66)*	*6.52 (3.84-10.97)*	*9.75 (6.08-15.45)*		274	0.74 (0.18-2.91)	3.39 (1.78-6.41)	*4.94 (2.90-8.36)*	*6.63 (4.17-10.47)*	*8.64 (5.56-13.30)*	*8.64 (5.56-13.30)*
unconstrained, mobile	<55	72	*0.00 (.-.)*	*2.82 (0.71-10.80)*	*4.38 (1.43-13.00)*	*11.03 (4.89-23.85)*			103	*0.97 (0.14-6.69)*	*1.97 (0.50-7.65)*	*3.03 (0.98-9.09)*	*6.43 (2.62-15.30)*		

Note: Total sample on which results are based is 1,442,051 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.K6 (continued)

Fixation, constraint and bearing type	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
posterior-stabilised, fixed	<55	48		0.00 (.-.)	2.78 (0.40-18.13)	9.18 (3.04-25.95)			58	0.00 (.-.)	2.22 (0.32-14.75)	6.99 (2.31-20.15)	9.38 (3.62-23.10)		
other constraints	<55	40	2.56 (0.37-16.84)	10.26 (3.98-25.06)	12.82 (5.55-28.10)	12.82 (5.55-28.10)	12.82 (5.55-28.10)		26			3.85 (0.55-24.31)	11.54 (3.87-31.64)	11.54 (3.87-31.64)	
All unicondylar, cemented	**<55**	**8,727**	**1.43 (1.20-1.71)**	**5.36 (4.89-5.88)**	**7.80 (7.21-8.42)**	**14.53 (13.62-15.50)**	**21.39 (19.88-22.99)**	*26.68 (22.00-32.14)*	**9,796**	**1.28 (1.08-1.53)**	**5.49 (5.04-5.98)**	**8.51 (7.93-9.12)**	**15.44 (14.57-16.36)**	**22.73 (21.27-24.28)**	*25.62 (22.76-28.78)*
fixed	<55	4,517	1.05 (0.79-1.41)	3.77 (3.21-4.41)	5.47 (4.76-6.28)	9.81 (8.54-11.25)	*14.06 (11.83-16.65)*		4,612	0.74 (0.52-1.04)	3.81 (3.26-4.46)	5.79 (5.06-6.63)	11.79 (10.37-13.40)	*16.05 (13.63-18.84)*	
mobile	<55	3,642	1.77 (1.38-2.25)	6.81 (6.03-7.68)	9.58 (8.65-10.60)	17.14 (15.84-18.53)	24.56 (22.61-26.64)	*30.46 (24.94-36.86)*	4,597	1.82 (1.47-2.25)	6.66 (5.97-7.42)	10.34 (9.48-11.28)	17.75 (16.57-19.00)	25.07 (23.28-26.97)	*28.49 (24.99-32.38)*
monobloc polyethylene tibia	<55	568	2.14 (1.22-3.73)	7.44 (5.53-9.97)	11.73 (9.26-14.81)	*21.10 (17.53-25.27)*	*26.48 (22.13-31.49)*		587	1.21 (0.58-2.52)	8.09 (6.12-10.65)	11.36 (8.99-14.32)	17.42 (14.32-21.11)	*27.62 (22.63-33.45)*	
All unicondylar, uncemented/hybrid	**<55**	**2,442**	**1.54 (1.12-2.14)**	**3.26 (2.59-4.10)**	**4.24 (3.43-5.25)**	*9.54 (7.66-11.86)*			**2,734**	**1.23 (0.87-1.74)**	**3.52 (2.85-4.35)**	**5.87 (4.89-7.03)**	*10.66 (8.65-13.10)*	*15.89 (11.78-21.26)*	
fixed	<55	121	*0.00 (.-.)*	*2.98 (0.97-8.99)*	*5.66 (2.36-13.24)*	*11.95 (5.90-23.37)*			142	*0.00 (.-.)*	*4.30 (1.81-10.05)*	*7.27 (3.42-15.08)*	*15.08 (7.56-28.82)*		
mobile	<55	2,292	1.65 (1.19-2.28)	3.22 (2.54-4.09)	4.06 (3.24-5.08)	*8.65 (6.79-10.99)*			2,552	1.32 (0.94-1.87)	3.44 (2.75-4.29)	5.68 (4.69-6.87)	*10.05 (7.96-12.66)*		
monobloc polyethylene tibia	<55	29		*6.90 (1.77-24.86)*	*10.62 (3.55-29.46)*	*28.32 (14.48-50.77)*			40		*5.00 (1.27-18.55)*	*10.00 (3.88-24.49)*	*17.83 (8.91-33.86)*		
Patellofemoral	**<55**	**1,212**	**2.47 (1.72-3.53)**	**9.19 (7.63-11.04)**	**13.30 (11.38-15.52)**	**21.88 (19.12-24.97)**	*30.87 (26.29-36.03)*		**5,276**	**0.80 (0.59-1.09)**	**5.92 (5.29-6.63)**	**9.60 (8.77-10.51)**	**19.03 (17.69-20.47)**	*26.42 (24.29-28.71)*	*33.78 (28.24-40.08)*
Multicompartmental	**<55**	**66**		*7.70 (3.28-17.52)*	*9.26 (4.27-19.47)*	*9.26 (4.27-19.47)*			**111**	*0.93 (0.13-6.45)*	*9.59 (5.27-17.09)*	*14.57 (9.05-23.01)*	*19.58 (12.53-29.86)*		
All cases	**55 to 64**	**157,948**	**0.70 (0.66-0.74)**	**2.39 (2.31-2.47)**	**3.49 (3.39-3.59)**	**5.55 (5.41-5.69)**	**7.96 (7.73-8.20)**	**9.58 (9.10-10.07)**	**186,122**	**0.47 (0.44-0.51)**	**2.12 (2.05-2.19)**	**3.18 (3.10-3.27)**	**5.27 (5.14-5.39)**	**7.38 (7.18-7.58)**	**8.63 (8.24-9.04)**
Unconfirmed	**55 to 64**	**2,688**	**0.91 (0.61-1.35)**	**2.89 (2.30-3.61)**	**3.65 (2.99-4.46)**	**6.32 (5.38-7.43)**	**8.96 (7.62-10.52)**	*9.49 (7.87-11.43)*	**3,067**	**0.60 (0.38-0.94)**	**2.79 (2.26-3.46)**	**3.57 (2.95-4.31)**	**6.20 (5.34-7.20)**	**8.73 (7.47-10.19)**	*11.35 (9.00-14.26)*
All cemented	**55 to 64**	**120,086**	**0.62 (0.58-0.67)**	**2.14 (2.06-2.23)**	**3.10 (2.99-3.20)**	**4.64 (4.49-4.78)**	**6.37 (6.14-6.61)**	**7.77 (7.23-8.34)**	**150,227**	**0.39 (0.36-0.42)**	**1.78 (1.71-1.85)**	**2.64 (2.55-2.73)**	**4.10 (3.98-4.23)**	**5.55 (5.35-5.74)**	**6.40 (5.99-6.83)**
unconstrained, fixed	55 to 64	84,063	0.55 (0.50-0.60)	1.97 (1.87-2.07)	2.81 (2.69-2.94)	4.13 (3.97-4.30)	5.84 (5.56-6.14)	7.47 (6.83-8.16)	104,481	0.37 (0.33-0.41)	1.65 (1.57-1.73)	2.37 (2.27-2.47)	3.64 (3.50-3.78)	5.07 (4.84-5.31)	6.04 (5.55-6.56)
unconstrained, mobile	55 to 64	4,748	0.77 (0.56-1.07)	2.66 (2.23-3.17)	3.83 (3.31-4.44)	5.86 (5.18-6.63)	7.52 (6.59-8.57)	*7.52 (6.59-8.57)*	5,714	0.50 (0.34-0.72)	2.07 (1.73-2.49)	3.13 (2.69-3.64)	4.99 (4.41-5.65)	6.19 (5.46-7.01)	*6.59 (5.69-7.61)*
posterior-stabilised, fixed	55 to 64	27,182	0.76 (0.66-0.88)	2.52 (2.33-2.72)	3.76 (3.52-4.01)	5.80 (5.47-6.16)	7.74 (7.23-8.28)	*9.11 (7.84-10.58)*	34,850	0.43 (0.36-0.50)	2.13 (1.98-2.29)	3.30 (3.11-3.51)	5.18 (4.90-5.47)	6.71 (6.29-7.16)	*7.44 (6.55-8.44)*

Note: Total sample on which results are based is 1,442,051 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.K6 (continued)

Fixation, constraint and bearing type	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
posterior-stabilised, mobile	55 to 64	1,968	0.83 (0.51-1.35)	2.45 (1.84-3.26)	3.08 (2.38-3.98)	4.66 (3.74-5.80)	*5.94 (4.68-7.54)*		2,231	0.32 (0.15-0.67)	1.74 (1.27-2.40)	2.93 (2.29-3.75)	4.46 (3.63-5.48)	6.14 (4.97-7.57)	*6.14 (4.97-7.57)*
constrained condylar	55 to 64	1,064	1.08 (0.60-1.95)	2.27 (1.48-3.46)	3.68 (2.56-5.27)	*4.70 (3.21-6.86)*	*4.70 (3.21-6.86)*		1,483	0.57 (0.28-1.13)	1.77 (1.16-2.68)	2.38 (1.62-3.48)	*6.04 (3.82-9.48)*	*8.00 (4.95-12.80)*	
monobloc polyethylene tibia	55 to 64	944	0.78 (0.37-1.63)	1.84 (1.13-2.98)	2.98 (2.00-4.42)	*3.70 (2.50-5.45)*	*3.70 (2.50-5.45)*		1,238	0.25 (0.08-0.77)	1.52 (0.95-2.44)	2.34 (1.57-3.49)	*3.47 (2.33-5.14)*	*4.98 (3.21-7.70)*	
pre-assembled/hinged/ linked	55 to 64	117	*5.43 (2.47-11.71)*	*11.47 (6.67-19.36)*	*14.07 (8.52-22.76)*	*19.61 (11.65-31.94)*			230	*3.27 (1.57-6.74)*	*3.80 (1.92-7.46)*	*5.68 (3.16-10.09)*	*9.03 (5.13-15.61)*		
All uncemented	**55 to 64**	**6,609**	**0.57 (0.42-0.79)**	**2.31 (1.96-2.71)**	**3.20 (2.78-3.67)**	**4.94 (4.38-5.56)**	**6.34 (5.62-7.16)**	*7.74 (6.31-9.47)*	**6,213**	**0.62 (0.45-0.86)**	**2.51 (2.14-2.94)**	**3.60 (3.14-4.11)**	**5.21 (4.63-5.85)**	**7.03 (6.24-7.91)**	*7.87 (6.57-9.41)*
unconstrained, fixed	55 to 64	2,706	0.50 (0.29-0.86)	2.49 (1.95-3.18)	3.34 (2.69-4.15)	5.52 (4.60-6.61)	6.71 (5.58-8.06)	*7.07 (5.79-8.62)*	2,365	0.70 (0.43-1.14)	2.90 (2.28-3.69)	3.69 (2.97-4.58)	5.41 (4.49-6.52)	7.04 (5.86-8.45)	*7.37 (6.06-8.96)*
unconstrained, mobile	55 to 64	3,216	0.51 (0.31-0.82)	2.21 (1.74-2.79)	3.24 (2.66-3.94)	4.37 (3.67-5.20)	5.96 (4.97-7.13)	*6.85 (5.39-8.68)*	3,405	0.54 (0.34-0.85)	2.22 (1.76-2.78)	3.46 (2.88-4.16)	4.81 (4.09-5.65)	6.45 (5.41-7.67)	*7.38 (5.52-9.84)*
posterior-stabilised, fixed	55 to 64	632	1.13 (0.54-2.35)	1.95 (1.11-3.41)	2.31 (1.38-3.88)	5.55 (3.79-8.07)	*7.01 (4.79-10.20)*		414	0.98 (0.37-2.58)	2.98 (1.70-5.19)	4.33 (2.71-6.88)	*7.61 (5.25-10.95)*	*11.67 (8.34-16.21)*	
other constraints	55 to 64	55	*1.82 (0.26-12.21)*	*3.82 (0.97-14.46)*	*3.82 (0.97-14.46)*	*6.06 (1.98-17.71)*			29		*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*		
All hybrid	**55 to 64**	**1,130**	**0.36 (0.14-0.96)**	**1.56 (0.98-2.51)**	**2.95 (2.08-4.17)**	**4.51 (3.37-6.03)**	*6.72 (5.09-8.87)*	*9.03 (6.28-12.89)*	**1,316**	**0.54 (0.26-1.13)**	**2.20 (1.53-3.17)**	**3.13 (2.29-4.26)**	**4.88 (3.77-6.32)**	**5.19 (4.01-6.70)**	*5.96 (4.48-7.90)*
unconstrained, fixed	55 to 64	709	0.29 (0.07-1.14)	1.45 (0.78-2.68)	2.81 (1.80-4.38)	4.15 (2.86-6.00)	*5.89 (4.17-8.28)*	*6.67 (4.56-9.69)*	826	0.85 (0.41-1.78)	2.60 (1.70-3.96)	3.63 (2.54-5.19)	5.17 (3.82-6.99)	*5.56 (4.13-7.47)*	*6.03 (4.41-8.23)*
unconstrained, mobile	55 to 64	223	*0.45 (0.06-3.14)*	*0.45 (0.06-3.14)*	*1.90 (0.72-4.99)*	*1.90 (0.72-4.99)*	*6.54 (2.22-18.47)*		325	0.00 (.-.)	1.26 (0.47-3.31)	1.59 (0.66-3.78)	*5.10 (2.46-10.42)*	*5.10 (2.46-10.42)*	
posterior-stabilised, fixed	55 to 64	120	*0.00 (.-.)*	*2.08 (0.52-8.12)*	*3.71 (1.17-11.42)*	*7.25 (3.00-16.98)*			111	*0.00 (.-.)*	*2.14 (0.54-8.29)*	*4.90 (1.85-12.63)*	*7.96 (3.62-17.04)*	*7.96 (3.62-17.04)*	
other constraints	55 to 64	78	*1.28 (0.18-8.75)*	*5.15 (1.96-13.13)*	*6.46 (2.74-14.84)*	*11.85 (5.99-22.72)*	*14.79 (7.64-27.55)*		54		*1.89 (0.27-12.65)*	*1.89 (0.27-12.65)*	*1.89 (0.27-12.65)*	*1.89 (0.27-12.65)*	
All unicondylar, cemented	**55 to 64**	**19,883**	**0.92 (0.80-1.07)**	**3.61 (3.34-3.89)**	**5.43 (5.09-5.78)**	**9.72 (9.22-10.26)**	**15.50 (14.62-16.43)**	*18.18 (16.72-19.74)*	**16,420**	**0.89 (0.75-1.05)**	**3.89 (3.59-4.22)**	**6.11 (5.72-6.52)**	**11.51 (10.92-12.12)**	**16.95 (16.03-17.92)**	*20.17 (18.46-22.03)*
fixed	55 to 64	9,190	0.50 (0.37-0.67)	2.05 (1.75-2.39)	3.48 (3.05-3.97)	6.57 (5.77-7.47)	*11.30 (9.43-13.52)*	*11.30 (9.43-13.52)*	6,871	0.61 (0.45-0.84)	2.95 (2.54-3.43)	4.49 (3.95-5.11)	8.30 (7.32-9.40)	*13.62 (11.39-16.23)*	*16.15 (12.22-21.18)*
mobile	55 to 64	9,468	1.32 (1.11-1.57)	4.73 (4.31-5.18)	6.73 (6.23-7.27)	11.43 (10.75-12.16)	17.46 (16.38-18.60)	*20.53 (18.78-22.42)*	8,456	1.16 (0.95-1.41)	4.45 (4.03-4.92)	7.05 (6.51-7.63)	12.89 (12.13-13.70)	18.63 (17.51-19.81)	*22.03 (20.06-24.17)*
monobloc polyethylene tibia	55 to 64	1,225	0.76 (0.40-1.45)	4.71 (3.63-6.11)	6.76 (5.43-8.41)	11.11 (9.27-13.29)	*15.82 (13.23-18.85)*		1,093	0.37 (0.14-0.99)	4.61 (3.50-6.08)	6.39 (5.05-8.08)	11.90 (9.91-14.24)	*14.95 (12.49-17.85)*	

Note: Total sample on which results are based is 1,442,051 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.K6 (continued)

Fixation, constraint and bearing type	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
All unicondylar, uncemented/hybrid	55 to 64	6,247	1.44 (1.16-1.78)	2.59 (2.20-3.05)	3.74 (3.22-4.34)	6.89 (5.74-8.25)	*10.54 (7.93-13.94)*		4,862	1.06 (0.80-1.41)	2.81 (2.35-3.37)	4.09 (3.48-4.82)	9.16 (7.66-10.93)	*14.36 (10.39-19.67)*	
fixed	55 to 64	205	*0.00 (.-.)*	*1.17 (0.29-4.61)*	*6.20 (3.11-12.17)*	*8.94 (4.75-16.48)*			192	*0.00 (.-.)*	*1.84 (0.60-5.60)*	*5.24 (2.50-10.81)*	*11.31 (6.03-20.66)*		
mobile	55 to 64	5,976	1.50 (1.22-1.86)	2.67 (2.27-3.15)	3.66 (3.14-4.26)	6.57 (5.40-7.97)	*11.08 (7.87-15.50)*		4,567	1.11 (0.83-1.47)	2.86 (2.37-3.44)	4.00 (3.37-4.75)	9.07 (7.46-11.00)	*14.48 (9.35-22.04)*	
monobloc polyethylene tibia	55 to 64	66		*0.00 (.-.)*	*1.67 (0.24-11.25)*	*8.92 (3.80-20.16)*			103	*0.97 (0.14-6.69)*	*2.93 (0.96-8.81)*	*4.95 (2.09-11.50)*	*8.66 (4.39-16.70)*		
Patellofemoral	55 to 64	1,189	1.84 (1.20-2.80)	5.86 (4.61-7.43)	10.72 (8.96-12.80)	21.97 (19.11-25.19)	*28.01 (24.03-32.50)*		3,901	0.85 (0.60-1.20)	5.28 (4.60-6.07)	9.35 (8.41-10.39)	17.15 (15.76-18.65)	*24.87 (22.64-27.28)*	*28.03 (24.90-31.48)*
Multicompartmental	55 to 64	116	*0.00 (.-.)*	*6.37 (3.09-12.90)*	*8.27 (4.39-15.30)*	*12.10 (6.98-20.54)*			116	*1.84 (0.46-7.14)*	*7.58 (3.86-14.59)*	*9.63 (5.30-17.18)*	*15.51 (9.28-25.28)*		
All cases	65 to 74	249,378	0.53 (0.50-0.56)	1.61 (1.56-1.67)	2.25 (2.19-2.32)	3.46 (3.37-3.55)	4.75 (4.60-4.91)	5.51 (5.16-5.88)	306,011	0.36 (0.34-0.39)	1.40 (1.36-1.45)	2.06 (2.01-2.12)	3.26 (3.18-3.34)	4.28 (4.16-4.41)	4.84 (4.60-5.10)
Unconfirmed	65 to 74	3,781	0.62 (0.41-0.93)	1.83 (1.44-2.32)	2.78 (2.28-3.38)	4.24 (3.59-5.02)	5.85 (4.82-7.09)	*7.16 (5.63-9.08)*	4,427	0.57 (0.39-0.85)	1.76 (1.41-2.21)	2.46 (2.03-2.98)	4.27 (3.66-4.98)	5.59 (4.74-6.58)	*6.00 (4.89-7.36)*
All cemented	65 to 74	208,489	0.47 (0.44-0.50)	1.45 (1.40-1.51)	2.04 (1.97-2.10)	3.00 (2.91-3.09)	3.99 (3.84-4.15)	4.49 (4.14-4.86)	268,174	0.32 (0.30-0.34)	1.23 (1.19-1.28)	1.81 (1.76-1.87)	2.72 (2.64-2.80)	3.41 (3.29-3.52)	3.90 (3.63-4.19)
unconstrained, fixed	65 to 74	147,716	0.45 (0.42-0.49)	1.35 (1.29-1.41)	1.86 (1.79-1.94)	2.66 (2.56-2.77)	3.61 (3.44-3.80)	4.13 (3.68-4.65)	185,134	0.27 (0.25-0.30)	1.13 (1.08-1.18)	1.63 (1.57-1.70)	2.44 (2.35-2.53)	3.16 (3.02-3.30)	3.58 (3.29-3.89)
unconstrained, mobile	65 to 74	6,847	0.46 (0.33-0.66)	1.80 (1.50-2.15)	2.64 (2.27-3.07)	3.94 (3.46-4.50)	4.99 (4.33-5.75)	*5.39 (4.44-6.55)*	8,836	0.42 (0.31-0.59)	1.61 (1.36-1.90)	2.33 (2.03-2.69)	3.58 (3.17-4.04)	4.20 (3.70-4.76)	*4.20 (3.70-4.76)*
posterior-stabilised, fixed	65 to 74	47,076	0.52 (0.46-0.59)	1.67 (1.55-1.79)	2.38 (2.24-2.54)	3.77 (3.56-3.99)	4.87 (4.54-5.23)	*5.29 (4.77-5.88)*	64,167	0.40 (0.35-0.45)	1.39 (1.30-1.49)	2.14 (2.02-2.27)	3.25 (3.09-3.43)	3.91 (3.69-4.15)	4.67 (4.03-5.40)
posterior-stabilised, mobile	65 to 74	2,106	0.49 (0.26-0.90)	1.90 (1.39-2.60)	2.61 (1.99-3.42)	3.30 (2.55-4.25)	*3.86 (2.97-4.99)*		2,548	0.60 (0.36-0.99)	1.88 (1.42-2.51)	2.51 (1.95-3.22)	3.84 (3.08-4.78)	*4.68 (3.63-6.01)*	*5.34 (3.85-7.38)*
constrained condylar	65 to 74	1,661	0.86 (0.50-1.48)	2.32 (1.65-3.28)	3.06 (2.23-4.20)	*4.29 (2.91-6.31)*	*8.75 (4.18-17.82)*		2,804	0.97 (0.66-1.42)	2.08 (1.58-2.73)	2.79 (2.17-3.59)	*3.09 (2.40-3.98)*	*3.09 (2.40-3.98)*	
monobloc polyethylene tibia	65 to 74	2,898	0.11 (0.03-0.33)	1.42 (1.03-1.96)	1.87 (1.40-2.49)	2.33 (1.77-3.07)	*2.60 (1.89-3.57)*		4,298	0.36 (0.22-0.60)	1.41 (1.09-1.83)	1.89 (1.50-2.38)	2.42 (1.94-3.03)	*2.59 (2.03-3.30)*	
pre-assembled/hinged/ linked	65 to 74	185	*2.81 (1.18-6.62)*	*7.98 (4.70-13.39)*	*9.78 (5.96-15.83)*	*12.59 (8.02-19.47)*			387	1.37 (0.57-3.26)	3.28 (1.83-5.87)	*4.83 (2.92-7.94)*	*5.99 (3.45-10.31)*	*5.99 (3.45-10.31)*	
All uncemented	65 to 74	9,284	0.58 (0.45-0.76)	1.81 (1.55-2.11)	2.32 (2.02-2.67)	3.31 (2.92-3.75)	4.09 (3.58-4.67)	*4.95 (3.71-6.59)*	9,245	0.46 (0.34-0.62)	2.18 (1.89-2.51)	2.91 (2.57-3.29)	3.73 (3.33-4.18)	4.73 (4.20-5.33)	*5.38 (4.57-6.32)*
unconstrained, fixed	65 to 74	3,683	0.65 (0.43-0.97)	2.14 (1.71-2.69)	2.75 (2.24-3.37)	3.75 (3.11-4.53)	4.21 (3.49-5.09)	*5.49 (3.40-8.79)*	3,392	0.46 (0.28-0.76)	2.48 (1.99-3.08)	3.06 (2.51-3.74)	3.91 (3.25-4.70)	4.94 (4.08-5.97)	*5.26 (4.24-6.51)*
unconstrained, mobile	65 to 74	4,878	0.46 (0.30-0.70)	1.52 (1.21-1.91)	1.94 (1.58-2.39)	2.94 (2.45-3.53)	3.93 (3.22-4.80)	*4.37 (3.35-5.69)*	5,293	0.50 (0.34-0.73)	2.02 (1.67-2.45)	2.83 (2.40-3.33)	3.63 (3.12-4.22)	4.50 (3.84-5.27)	*5.43 (4.25-6.92)*

Note: Total sample on which results are based is 1,442,051 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.K6 (continued)

Fixation, constraint and bearing type	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
posterior-stabilised, fixed	65 to 74	629	1.13 (0.54-2.36)	2.15 (1.25-3.67)	2.93 (1.83-4.69)	*3.75 (2.41-5.81)*	*4.97 (3.07-7.99)*		528	0.19 (0.03-1.34)	2.02 (1.09-3.72)	2.92 (1.74-4.88)	*3.92 (2.42-6.32)*	*5.86 (3.52-9.68)*	
other constraints	65 to 74	94	*1.06 (0.15-7.31)*	*2.18 (0.55-8.42)*	*2.18 (0.55-8.42)*	*2.18 (0.55-8.42)*			32		*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*		
All hybrid	**65 to 74**	**1,772**	**0.46 (0.23-0.92)**	**1.71 (1.19-2.46)**	**1.98 (1.41-2.77)**	**2.90 (2.16-3.90)**	**3.67 (2.73-4.94)**	*3.67 (2.73-4.94)*	**2,051**	**0.59 (0.33-1.03)**	**1.66 (1.18-2.33)**	**1.89 (1.37-2.60)**	**2.64 (1.99-3.50)**	**3.21 (2.43-4.25)**	*3.21 (2.43-4.25)*
unconstrained, fixed	65 to 74	1,229	0.33 (0.12-0.88)	1.60 (1.03-2.50)	1.88 (1.24-2.84)	2.66 (1.85-3.81)	*3.19 (2.23-4.54)*	*3.19 (2.23-4.54)*	1,339	0.30 (0.11-0.80)	1.22 (0.75-1.98)	1.22 (0.75-1.98)	2.04 (1.38-3.01)	2.64 (1.81-3.83)	*2.64 (1.81-3.83)*
unconstrained, mobile	65 to 74	318	1.26 (0.47-3.32)	1.91 (0.86-4.19)	*2.27 (1.09-4.70)*	*3.64 (1.95-6.72)*	*6.96 (3.36-14.14)*		488	1.64 (0.83-3.26)	3.35 (2.07-5.41)	4.10 (2.63-6.37)	*4.78 (3.12-7.28)*	*5.67 (3.54-9.04)*	
posterior-stabilised, fixed	65 to 74	156	*0.00 (.-.)*	*3.22 (1.22-8.37)*	*3.22 (1.22-8.37)*	*5.05 (1.98-12.55)*	*5.05 (1.98-12.55)*		179	*0.00 (.-.)*	*0.78 (0.11-5.37)*	*1.84 (0.46-7.29)*	*1.84 (0.46-7.29)*	*1.84 (0.46-7.29)*	
other constraints	65 to 74	69	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*		45			*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	
All unicondylar, cemented	**65 to 74**	**18,516**	**0.83 (0.70-0.97)**	**2.81 (2.57-3.07)**	**3.96 (3.66-4.28)**	**7.21 (6.75-7.71)**	**11.25 (10.42-12.13)**	*13.81 (12.05-15.81)*	**14,624**	**0.72 (0.60-0.88)**	**2.85 (2.58-3.15)**	**4.54 (4.18-4.92)**	**8.95 (8.37-9.56)**	**13.26 (12.34-14.24)**	*14.87 (13.47-16.41)*
fixed	65 to 74	8,266	0.57 (0.42-0.76)	2.03 (1.72-2.40)	2.73 (2.34-3.19)	5.00 (4.24-5.90)	*7.71 (6.09-9.74)*		6,129	0.45 (0.31-0.67)	1.89 (1.55-2.32)	2.93 (2.46-3.49)	5.60 (4.68-6.71)	*6.87 (5.62-8.38)*	
mobile	65 to 74	9,096	1.10 (0.90-1.33)	3.35 (2.99-3.75)	4.62 (4.20-5.08)	8.33 (7.71-9.00)	12.62 (11.62-13.70)	*15.14 (13.09-17.49)*	7,619	0.98 (0.78-1.23)	3.46 (3.07-3.90)	5.48 (4.98-6.03)	10.56 (9.81-11.37)	15.33 (14.21-16.53)	*16.56 (15.22-18.01)*
monobloc polyethylene tibia	65 to 74	1,154	0.44 (0.19-1.07)	3.16 (2.27-4.39)	5.40 (4.17-6.98)	7.06 (5.57-8.92)	*10.46 (8.19-13.30)*		876	0.23 (0.06-0.93)	3.16 (2.16-4.61)	4.50 (3.27-6.19)	6.77 (5.13-8.92)	*10.42 (7.88-13.73)*	
All unicondylar, uncemented/hybrid	**65 to 74**	**6,650**	**1.15 (0.91-1.44)**	**2.31 (1.95-2.73)**	**3.10 (2.64-3.63)**	**5.43 (4.42-6.67)**	*7.62 (5.59-10.35)*		**5,080**	**1.00 (0.76-1.33)**	**2.51 (2.08-3.03)**	**3.59 (3.02-4.27)**	**7.71 (6.23-9.53)**	*11.60 (7.84-16.99)*	
fixed	65 to 74	192	*0.54 (0.08-3.75)*	*4.86 (2.46-9.50)*	*7.49 (4.17-13.28)*	*10.08 (5.78-17.28)*			245	*0.00 (.-.)*	*1.74 (0.56-5.32)*	*5.13 (2.44-10.61)*	*8.46 (4.53-15.52)*		
mobile	65 to 74	6,389	1.16 (0.92-1.47)	2.19 (1.84-2.62)	2.89 (2.45-3.42)	5.35 (4.24-6.74)	*8.17 (5.68-11.69)*		4,739	1.08 (0.81-1.43)	2.55 (2.11-3.09)	3.49 (2.92-4.17)	*8.20 (6.38-10.51)*		
monobloc polyethylene tibia	65 to 74	69	*1.45 (0.21-9.84)*	*4.44 (1.45-13.13)*	*5.98 (2.28-15.15)*	*7.57 (3.22-17.25)*			96	*0.00 (.-.)*	*2.14 (0.54-8.28)*	*3.24 (1.06-9.71)*	*4.53 (1.72-11.66)*		
Patellofemoral	**65 to 74**	**810**	**1.79 (1.07-3.01)**	**6.07 (4.57-8.05)**	**9.66 (7.67-12.13)**	*17.75 (14.63-21.46)*	*21.11 (16.10-27.41)*		**2,334**	**0.79 (0.50-1.26)**	**5.07 (4.23-6.07)**	**8.02 (6.93-9.28)**	**16.24 (14.51-18.17)**	*23.13 (20.24-26.36)*	*23.85 (20.70-27.40)*
Multicompartmental	**65 to 74**	**76**	*2.78 (0.70-10.65)*	*7.18 (3.05-16.40)*	*12.27 (6.31-23.14)*	*15.89 (8.83-27.67)*			**76**	*1.35 (0.19-9.21)*	*6.80 (2.89-15.56)*	*8.40 (3.85-17.80)*	*10.10 (4.92-20.11)*		
All cases	**≥75**	**176,409**	**0.44 (0.41-0.47)**	**1.11 (1.06-1.16)**	**1.45 (1.39-1.51)**	**2.11 (2.02-2.20)**	**2.56 (2.39-2.73)**	*2.59 (2.42-2.79)*	**258,529**	**0.39 (0.37-0.42)**	**1.02 (0.98-1.06)**	**1.39 (1.34-1.44)**	**2.03 (1.96-2.10)**	**2.51 (2.40-2.62)**	**3.26 (2.70-3.92)**
Unconfirmed	**≥75**	**2,493**	**0.33 (0.17-0.66)**	**0.96 (0.63-1.45)**	**1.54 (1.09-2.16)**	**2.86 (2.15-3.78)**	*2.98 (2.25-3.95)*		**3,953**	**0.64 (0.44-0.95)**	**1.31 (0.99-1.73)**	**1.78 (1.40-2.27)**	**2.61 (2.10-3.25)**	*3.10 (2.43-3.95)*	*3.10 (2.43-3.95)*

Note: Total sample on which results are based is 1,442,051 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.K6 (continued)

Fixation, constraint and bearing type	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
All cemented	≥75	155,004	0.40 (0.37-0.43)	1.03 (0.98-1.08)	1.34 (1.28-1.40)	1.88 (1.79-1.97)	2.24 (2.09-2.40)	*2.28 (2.11-2.47)*	234,354	0.35 (0.33-0.38)	0.92 (0.88-0.97)	1.25 (1.20-1.30)	1.78 (1.72-1.86)	2.18 (2.08-2.30)	2.87 (2.27-3.63)
unconstrained, fixed	≥75	107,732	0.37 (0.34-0.41)	0.98 (0.92-1.04)	1.26 (1.19-1.33)	1.76 (1.66-1.87)	2.14 (1.95-2.35)	*2.21 (1.98-2.47)*	156,694	0.31 (0.29-0.34)	0.86 (0.82-0.91)	1.16 (1.10-1.22)	1.68 (1.59-1.76)	2.07 (1.94-2.21)	*2.99 (2.14-4.18)*
unconstrained, mobile	≥75	4,587	0.40 (0.25-0.64)	1.02 (0.76-1.38)	1.50 (1.16-1.93)	1.98 (1.55-2.53)	*2.15 (1.63-2.83)*		7,837	0.43 (0.31-0.60)	0.92 (0.73-1.17)	1.33 (1.08-1.63)	1.83 (1.51-2.22)	2.20 (1.78-2.71)	*2.20 (1.78-2.71)*
posterior-stabilised, fixed	≥75	36,100	0.47 (0.40-0.55)	1.14 (1.03-1.27)	1.52 (1.39-1.67)	2.19 (1.99-2.40)	2.59 (2.29-2.92)	*2.59 (2.29-2.92)*	58,564	0.39 (0.34-0.44)	1.02 (0.94-1.11)	1.42 (1.32-1.53)	2.00 (1.86-2.15)	2.44 (2.21-2.68)	*2.72 (2.35-3.15)*
posterior-stabilised, mobile	≥75	1,196	0.52 (0.23-1.15)	1.34 (0.81-2.21)	1.46 (0.90-2.39)	1.76 (1.10-2.81)	*1.76 (1.10-2.81)*		1,877	0.54 (0.29-1.01)	1.08 (0.69-1.69)	1.42 (0.95-2.12)	1.97 (1.34-2.88)	*2.49 (1.63-3.79)*	
constrained condylar	≥75	1,347	1.03 (0.60-1.77)	1.86 (1.21-2.85)	2.05 (1.33-3.14)	*2.44 (1.51-3.94)*			2,928	1.11 (0.78-1.57)	1.75 (1.30-2.34)	2.15 (1.61-2.88)	*2.40 (1.78-3.23)*	*2.40 (1.78-3.23)*	
monobloc polyethylene tibia	≥75	3,793	0.27 (0.15-0.51)	0.96 (0.68-1.35)	1.20 (0.87-1.64)	1.48 (1.09-2.01)			5,500	0.43 (0.29-0.65)	0.81 (0.60-1.09)	1.10 (0.84-1.45)	1.48 (1.11-1.97)	*1.48 (1.11-1.97)*	
pre-assembled/hinged/ linked	≥75	249	*1.24 (0.40-3.79)*	*3.21 (1.54-6.63)*	*3.87 (1.93-7.65)*	*6.25 (3.18-12.11)*			954	1.38 (0.78-2.42)	2.67 (1.74-4.09)	3.96 (2.69-5.82)	*5.92 (3.76-9.25)*		
All uncemented	≥75	5,895	0.51 (0.35-0.73)	1.33 (1.05-1.67)	1.71 (1.39-2.10)	2.23 (1.83-2.70)	*2.30 (1.89-2.80)*	*2.30 (1.89-2.80)*	7,497	0.53 (0.39-0.73)	1.25 (1.02-1.54)	1.57 (1.30-1.89)	1.88 (1.57-2.25)	2.50 (2.02-3.08)	*4.53 (1.87-10.75)*
unconstrained, fixed	≥75	2,340	0.58 (0.34-1.00)	1.17 (0.79-1.72)	1.59 (1.12-2.24)	1.93 (1.38-2.69)	*2.09 (1.48-2.94)*		2,915	0.75 (0.49-1.14)	1.54 (1.14-2.07)	1.94 (1.47-2.54)	1.94 (1.47-2.54)	*2.49 (1.83-3.39)*	
unconstrained, mobile	≥75	3,143	0.49 (0.30-0.81)	1.30 (0.95-1.79)	1.63 (1.22-2.17)	2.23 (1.71-2.90)	*2.23 (1.71-2.90)*		4,062	0.40 (0.24-0.65)	1.11 (0.82-1.49)	1.29 (0.97-1.70)	1.73 (1.33-2.23)	*2.28 (1.69-3.08)*	
posterior-stabilised, fixed	≥75	368	0.27 (0.04-1.93)	2.38 (1.19-4.70)	*3.04 (1.64-5.58)*	*4.03 (2.28-7.09)*	*4.03 (2.28-7.09)*		509	0.40 (0.10-1.58)	0.81 (0.31-2.15)	1.94 (0.96-3.88)	*3.11 (1.69-5.68)*	*4.81 (2.18-10.46)*	
other constraints	≥75	44	*0.00 (.-.)*	*2.38 (0.34-15.72)*	*2.38 (0.34-15.72)*	*2.38 (0.34-15.72)*			11						
All hybrid	≥75	1,228	0.42 (0.18-1.01)	0.87 (0.47-1.61)	1.23 (0.71-2.12)	2.08 (1.28-3.36)	*2.08 (1.28-3.36)*		1,787	0.63 (0.35-1.14)	1.30 (0.86-1.96)	1.51 (1.02-2.23)	2.13 (1.48-3.06)	*2.13 (1.48-3.06)*	*2.13 (1.48-3.06)*
unconstrained, fixed	≥75	842	0.37 (0.12-1.15)	0.89 (0.43-1.86)	1.39 (0.75-2.58)	2.30 (1.34-3.93)	*2.30 (1.34-3.93)*		1,163	0.61 (0.29-1.28)	1.16 (0.67-1.98)	1.47 (0.90-2.39)	2.15 (1.39-3.32)	*2.15 (1.39-3.32)*	*2.15 (1.39-3.32)*
unconstrained, mobile	≥75	221	*0.91 (0.23-3.59)*	*0.91 (0.23-3.59)*	*0.91 (0.23-3.59)*	*0.91 (0.23-3.59)*			434	0.94 (0.35-2.49)	1.44 (0.65-3.17)	1.44 (0.65-3.17)	*1.92 (0.89-4.12)*		
posterior-stabilised, fixed	≥75	107	*0.00 (.-.)*	*1.20 (0.17-8.25)*	*1.20 (0.17-8.25)*	*1.20 (0.17-8.25)*			144	*0.00 (.-.)*	*2.94 (0.95-8.92)*	*2.94 (0.95-8.92)*	*2.94 (0.95-8.92)*		
other constraints	≥75	58	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*2.63 (0.37-17.25)*			46	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*		

Note: Total sample on which results are based is 1,442,051 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

Table 3.K6 (continued)

Fixation, constraint and bearing type	Age at primary (years)	Male							Female						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	15 years	18 years		1 year	3 years	5 years	10 years	15 years	18 years
All unicondylar, cemented	≥75	8,158	0.79 (0.62-1.02)	2.02 (1.72-2.38)	2.85 (2.47-3.29)	5.03 (4.39-5.76)	*7.09 (5.68-8.83)*	*7.09 (5.68-8.83)*	7,261	1.06 (0.84-1.33)	2.94 (2.55-3.38)	4.35 (3.86-4.91)	7.41 (6.66-8.24)	9.49 (8.32-10.82)	*11.05 (8.73-13.94)*
fixed	≥75	3,752	0.50 (0.31-0.80)	1.19 (0.85-1.65)	1.79 (1.31-2.43)	*3.40 (2.29-5.03)*	*5.31 (2.97-9.38)*		3,009	0.70 (0.45-1.10)	2.20 (1.68-2.89)	3.17 (2.47-4.07)	*5.04 (3.84-6.59)*	*5.04 (3.84-6.59)*	
mobile	≥75	3,855	1.11 (0.82-1.49)	2.72 (2.24-3.31)	3.62 (3.05-4.29)	5.89 (5.06-6.85)	*8.20 (6.47-10.36)*	*8.20 (6.47-10.36)*	3,773	1.31 (0.99-1.74)	3.55 (2.99-4.20)	5.18 (4.49-5.96)	8.59 (7.62-9.68)	*11.26 (9.76-12.97)*	
monobloc polyethylene tibia	≥75	551	0.37 (0.09-1.46)	1.55 (0.78-3.08)	2.77 (1.61-4.74)	*5.71 (3.57-9.08)*	*5.71 (3.57-9.08)*		479	1.07 (0.45-2.55)	1.97 (1.03-3.75)	3.19 (1.90-5.34)	*5.51 (3.58-8.43)*	*5.51 (3.58-8.43)*	
All unicondylar, uncemented/hybrid	≥75	3,069	1.28 (0.93-1.77)	2.01 (1.54-2.63)	2.59 (1.99-3.38)	*4.71 (3.15-7.02)*			2,424	0.69 (0.42-1.12)	1.99 (1.46-2.72)	2.89 (2.18-3.82)	*4.48 (3.25-6.17)*		
fixed	≥75	104	*1.02 (0.14-7.02)*	*1.02 (0.14-7.02)*	*1.02 (0.14-7.02)*	*6.91 (2.08-21.65)*			220	*0.46 (0.06-3.21)*	*1.71 (0.55-5.26)*	*2.63 (0.96-7.06)*	*3.98 (1.56-9.94)*		
mobile	≥75	2,929	1.31 (0.95-1.81)	2.08 (1.59-2.72)	2.70 (2.07-3.53)	*4.70 (3.01-7.31)*			2,167	0.72 (0.44-1.20)	2.06 (1.49-2.85)	2.99 (2.23-4.01)	*4.86 (3.36-6.99)*		
monobloc polyethylene tibia	≥75	36		*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*			37			*0.00 (.-.)*	*0.00 (.-.)*		
Patellofemoral	≥75	528	0.60 (0.19-1.85)	3.04 (1.81-5.09)	3.90 (2.43-6.23)	*6.53 (4.11-10.32)*	*9.09 (5.44-14.99)*		1,226	0.58 (0.28-1.22)	2.65 (1.86-3.78)	5.60 (4.34-7.21)	9.33 (7.45-11.65)	*9.33 (7.45-11.65)*	
Multicompartmental	≥75	34	*0.00 (.-.)*	*4.17 (0.60-26.08)*	*4.17 (0.60-26.08)*				27	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*			

Note: Total sample on which results are based is 1,442,051 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: The observed outcomes outlined here represent aggregate analysis outputs. For an individual patient level estimate of outcome based upon individual patient characteristics, prosthesis selection and surgical technique chosen, we recommend review of the NJR Patient Decision Support Tool

UKRs seem to fare worse compared to TKR, with the chance of revision at each estimated time point being approximately double or more than that of a TKR (Table 3.K5, page 149). The revision rate for cemented unicondylar (medial or lateral UKR) knee replacements is 3.2 times higher than the observed rate for cemented TKR at ten years and 3.5 times higher at 18 years. The revision rate for uncemented unicondylar (medial or lateral UKR) knee replacements is 2.3 times higher than for cemented TKR at ten years and 2.7 times higher at 15 years, although the numbers for the last estimate are small and so we suggest should be treated with caution. The revision rate for patellofemoral replacement is 5.6 times higher than for cemented TKR at ten years and 5.4 times higher at 18 years although again, we advise a degree of caution since the number of patellofemoral replacements at risk at 18 years is small. Multicompartmental knee replacements have relatively small numbers, and at five years the risk of revision is 4.3 times higher than for cemented TKR, 1.8 times higher than for cemented unicondylar knee replacements and 2.6 times higher than for uncemented unicondylar knee replacements. The rates are approximately equivalent to those seen for patellofemoral replacements.

First revision of an implant is slightly less likely in females than in males overall for cemented TKR but, broadly, a patient from a younger age group is more likely to be revised irrespective of gender, with the youngest group having the worst predicted outcome in terms of the risk of subsequent revision (Table 3.K6, page 157). Conversely, female patients are more likely to have a unicondylar implant revised in the longer term compared to their male, age-equivalent counterparts. For patellofemoral implants, males are generally more likely to undergo revision than their age-matched female counterparts.

The numbers for multicompartmental knee replacements are small in the age and gender stratified groups but overall, the risk of revision is markedly higher than that for TKR and more in keeping with patellofemoral replacement.

3.3.3 Revisions after primary knee replacement surgery by main brands for TKR and UKR

As in previous reports, only brands that have been used in a primary TKR in 1,000 or more operations have been included (Tables 3.K7 (a) (page 171) and Table 3.K8 (page 172)). Table 3.K7 (b) (page 167) shows a breakdown of the brands included in Table 3.K7 (a) according to whether the patella was resurfaced or not at the time of the primary procedure. In Table 3.K9 (a) (page 173) brands are displayed with a breakdown according to fixation, constraint and bearing mobility where there are more than 2,500 operations for TKR and more than 1,000 operations for UKR. Table 3.K9 (b) (page 177) provides an additional breakdown for the TKRs displayed in Table 3.K9 (a) according to whether the patella was resurfaced at the time of primary procedure or not.

Further breakdowns by component are available from other sources, such as ODEP. The figures in blue italics are at time points where fewer than 250 primary knee replacements remain at risk. No results are shown where the number had fallen below ten cases. We have made no attempt to adjust for other factors that may influence the chance of revision, so the figures are unadjusted probabilities. Given that the sub-groups may differ in composition with respect to age and gender, the percentage of males and the median (IQR) of the ages are also shown in these tables.

Table 3.K7 (a) KM estimates of cumulative revision (95% CI) by total knee replacement brands. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
All total knee replacements	1,265,502	70 (63 to 76)	43	0.43 (0.42-0.44)	1.47 (1.45-1.49)	2.10 (2.07-2.13)	3.19 (3.15-3.23)	4.31 (4.24-4.37)	5.12 (4.96-5.29)
ACS PC[Fem]ACS[Tib]	1,171	68 (61 to 73)	50	0.77 (0.40-1.48)	2.64 (1.86-3.76)	3.21 (2.33-4.43)	4.50 (3.35-6.04)		
Advance MP Stature[Fem] Advance[Tib]	1,507	69 (62 to 75)	13	0.07 (0.01-0.47)	1.70 (1.15-2.50)	2.66 (1.94-3.64)	3.31 (2.43-4.51)		
Advance MP[Fem] Advance[Tib]	9,005	70 (64 to 76)	48	0.57 (0.43-0.75)	2.03 (1.76-2.35)	2.85 (2.52-3.23)	4.09 (3.65-4.58)	4.73 (4.17-5.36)	*6.05 (4.38-8.33)*
Advance PS[Fem] Advance[Tib]	1,444	72 (66 to 77)	45	0.63 (0.33-1.21)	2.59 (1.88-3.58)	3.34 (2.50-4.45)	5.69 (4.39-7.37)	*7.11 (5.42-9.30)*	
AGC V2[Fem:Tib]	39,151	71 (65 to 77)	43	0.31 (0.26-0.38)	1.52 (1.41-1.65)	2.20 (2.05-2.35)	3.47 (3.28-3.67)	5.42 (5.11-5.75)	7.64 (6.79-8.59)
AGC[Fem]AGC V2[Tib]	28,950	71 (64 to 77)	42	0.30 (0.24-0.37)	1.58 (1.44-1.73)	2.22 (2.05-2.40)	3.52 (3.29-3.76)	5.31 (4.90-5.77)	*6.78 (5.88-7.80)*
AS Columbus Cemented[Fem] Columbus CR/PS[Tib]	1,653	66 (59 to 73)	53	0.46 (0.22-0.97)	1.76 (1.14-2.71)	2.76 (1.85-4.11)	*3.89 (2.48-6.06)*		
Attune[Fem] Attune FB[Tib]	33,769	70 (62 to 76)	44	0.39 (0.32-0.46)	1.44 (1.31-1.59)	2.06 (1.88-2.27)			
Attune[Fem] Attune RP[Tib]	5,770	70 (62 to 76)	44	0.26 (0.16-0.45)	0.92 (0.67-1.25)	1.37 (1.03-1.83)			
Columbus Cemented[Fem] Columbus CR/PS[Tib]	16,684	70 (64 to 77)	42	0.44 (0.35-0.56)	1.43 (1.25-1.63)	1.99 (1.77-2.23)	2.99 (2.65-3.38)	*3.69 (3.15-4.32)*	
E-Motion Bicondylar Knee[Fem] E-Motion FP[Tib]	3,378	68 (61 to 74)	45	0.66 (0.43-1.00)	2.31 (1.85-2.89)	3.29 (2.72-3.97)	4.40 (3.70-5.23)	*6.55 (4.98-8.60)*	
Endo-Model Standard Rotating Hinge[Fem:Tib]	1,385	76 (68 to 83)	28	1.39 (0.88-2.20)	3.34 (2.45-4.53)	4.89 (3.75-6.36)	*7.01 (5.31-9.24)*	*8.61 (6.32-11.68)*	
EvolutionMP[Fem:Tib]	2,088	70 (63 to 76)	45	0.46 (0.24-0.88)	1.48 (1.00-2.19)	1.84 (1.25-2.70)			
Genesis II Oxinium[Fem] Genesis II[Tib]	11,829	59 (54 to 65)	40	0.57 (0.45-0.73)	2.32 (2.06-2.62)	3.43 (3.09-3.80)	5.96 (5.44-6.53)	7.39 (6.65-8.21)	
Genesis II[Fem:Tib]	90,539	71 (65 to 77)	42	0.47 (0.43-0.52)	1.46 (1.38-1.55)	2.01 (1.91-2.11)	2.97 (2.83-3.12)	3.42 (3.20-3.64)	*3.56 (3.27-3.87)*
Insall-Burstein II Microport[Fem] Insall-Burstein (Microport)[Tib]	2,031	71 (65 to 77)	45	0.35 (0.17-0.73)	1.73 (1.24-2.42)	2.91 (2.25-3.77)	5.11 (4.18-6.25)	7.02 (5.85-8.41)	*7.69 (6.39-9.25)*
Journey II BCS Oxinium[Fem] Journey[Tib]	4,849	66 (59 to 73)	41	0.52 (0.34-0.78)	1.99 (1.59-2.51)	2.38 (1.91-2.97)			
Kinemax[Fem:Tib]	11,051	71 (64 to 77)	43	0.25 (0.17-0.36)	1.72 (1.49-1.98)	2.66 (2.37-2.99)	4.68 (4.28-5.12)	6.77 (6.24-7.33)	7.47 (6.80-8.19)
LCS Complete[Fem] M.B.T.[Tib]	29,926	70 (63 to 76)	44	0.42 (0.36-0.51)	1.67 (1.53-1.83)	2.47 (2.29-2.66)	3.61 (3.37-3.86)	4.39 (4.07-4.73)	
LCS[Fem:Tib]	2,087	70 (63 to 76)	41	0.63 (0.36-1.08)	1.71 (1.23-2.37)	2.22 (1.66-2.97)	2.87 (2.21-3.72)	3.64 (2.86-4.63)	*3.85 (3.03-4.89)*

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Legion CR COCR[Fem] Genesis II[Tib]	1,069	71 (65 to 77)	45	0.48 (0.20-1.14)	1.56 (0.96-2.53)	2.13 (1.39-3.25)			
Maxim[Fem:Tib]	1,751	70 (63 to 77)	43	0.41 (0.19-0.85)	1.77 (1.24-2.52)	2.76 (2.08-3.67)	5.49 (4.43-6.78)	9.21 (7.60-11.13)	*15.49 (10.81-21.93)*
MRK[Fem:Tib]	15,855	70 (64 to 77)	44	0.32 (0.24-0.42)	1.17 (1.01-1.36)	1.62 (1.42-1.85)	2.59 (2.28-2.93)	2.93 (2.53-3.40)	*3.25 (2.58-4.09)*
Natural Knee II[Fem] NK2[Tib]	2,824	70 (64 to 76)	42	0.32 (0.17-0.62)	1.37 (1.00-1.88)	2.24 (1.75-2.88)	3.97 (3.28-4.81)	6.60 (5.48-7.96)	*6.84 (5.64-8.28)*
Nexgen Hinge Type[Fem:Tib]	1,056	73 (64 to 80)	26	1.19 (0.68-2.09)	2.67 (1.79-3.97)	3.88 (2.72-5.54)	*7.47 (5.11-10.84)*	*9.36 (6.22-13.95)*	
Nexgen LCCK[Fem] Nexgen[Tib]	1,181	71 (64 to 79)	36	1.22 (0.72-2.04)	2.67 (1.85-3.85)	3.26 (2.30-4.62)	*4.85 (3.29-7.11)*	*8.20 (4.17-15.76)*	
Nexgen[Fem:Tib]	183,105	70 (64 to 76)	42	0.38 (0.35-0.41)	1.26 (1.20-1.31)	1.97 (1.90-2.04)	3.38 (3.27-3.49)	4.52 (4.33-4.71)	5.32 (4.80-5.90)
Nexgen[Fem] LPS (Legacy Posterior Stabilised ZimmerBiomet)[Tib]	3,319	67 (59 to 75)	46	0.46 (0.28-0.76)	1.84 (1.43-2.37)	2.56 (2.06-3.18)	4.20 (3.49-5.04)	5.90 (4.84-7.17)	*7.11 (5.51-9.14)*
Nexgen[Fem] TM Monoblock[Tib]	4,286	64 (58 to 71)	57	0.61 (0.42-0.90)	2.60 (2.16-3.13)	3.28 (2.78-3.87)	4.35 (3.76-5.05)	5.24 (4.51-6.08)	*5.62 (4.75-6.64)*
Optetrak CR[Fem] Optetrak[Tib]	1,641	70 (63 to 76)	43	0.86 (0.51-1.45)	3.44 (2.65-4.46)	4.89 (3.93-6.08)	8.17 (6.84-9.74)	*10.72 (8.75-13.10)*	
Persona CR[Fem] Persona[Tib]	7,706	70 (62 to 76)	45	0.33 (0.21-0.51)	0.82 (0.58-1.16)	1.37 (0.90-2.08)			
Persona PS[Fem] Persona[Tib]	1,712	70 (63 to 76)	43	0.50 (0.25-1.00)	1.93 (1.32-2.84)	3.22 (2.29-4.52)			
PFC Sigma Bicondylar Knee[Fem] M.B.T.[Tib]	17,483	65 (58 to 72)	47	0.63 (0.52-0.76)	2.00 (1.80-2.22)	2.77 (2.53-3.03)	3.93 (3.64-4.26)	4.99 (4.57-5.45)	*5.06 (4.62-5.55)*
PFC Sigma Bicondylar Knee[Fem] PFC Bicondylar[Tib]	177,771	70 (64 to 76)	43	0.39 (0.36-0.42)	1.27 (1.21-1.32)	1.75 (1.68-1.81)	2.47 (2.39-2.56)	3.20 (3.09-3.32)	3.69 (3.47-3.93)
PFC Sigma Bicondylar Knee[Fem] PFC Sigma Bicondylar[Tib]	201,837	70 (64 to 77)	42	0.37 (0.35-0.40)	1.38 (1.33-1.44)	1.93 (1.87-2.00)	2.60 (2.52-2.69)	*2.99 (2.80-3.19)*	
Profix Oxinium[Fem] Profix[Tib]	1,000	61 (56 to 66)	44	0.80 (0.40-1.60)	2.93 (2.04-4.19)	3.24 (2.30-4.55)	4.53 (3.39-6.04)	5.55 (4.25-7.23)	*5.55 (4.25-7.23)*
Profix[Fem:Tib]	3,977	73 (67 to 78)	44	0.41 (0.25-0.66)	1.37 (1.05-1.78)	1.86 (1.48-2.34)	2.70 (2.22-3.28)	3.60 (2.94-4.40)	*3.80 (3.05-4.73)*
Rotaglide +[Fem:Tib]	2,012	70 (63 to 76)	43	0.65 (0.38-1.12)	3.01 (2.34-3.87)	3.87 (3.10-4.83)	6.56 (5.50-7.81)	8.70 (7.39-10.24)	*8.70 (7.39-10.24)*
Rotaglide[Fem:Tib]	1,449	71 (63 to 77)	39	0.56 (0.28-1.11)	2.41 (1.72-3.35)	4.01 (3.09-5.20)	4.66 (3.63-5.97)	*6.41 (4.88-8.40)*	
Saiph[Fem:Tib]	2,416	69 (63 to 75)	43	0.62 (0.36-1.06)	1.31 (0.87-1.96)	1.40 (0.94-2.09)			
Scorpio NRG[Fem:Tib]	14,111	70 (64 to 77)	42	0.41 (0.32-0.53)	1.58 (1.39-1.81)	2.41 (2.16-2.68)	3.63 (3.31-3.99)	*4.30 (3.85-4.81)*	
Scorpio[Fem:Tib]	3,272	68 (61 to 75)	45	0.37 (0.21-0.65)	2.16 (1.71-2.73)	3.11 (2.56-3.78)	4.65 (3.95-5.47)	5.96 (5.06-7.02)	*7.97 (5.48-11.52)*
Scorpio[Fem] Scorpio NRG[Tib]	21,808	71 (64 to 77)	42	0.44 (0.36-0.54)	1.82 (1.65-2.01)	2.61 (2.41-2.84)	4.00 (3.74-4.28)	5.14 (4.81-5.49)	*5.59 (5.11-6.12)*

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Sphere[Fem]GMK[Tib]	2,192	69 (62 to 75)	43	1.06 (0.69-1.62)	2.14 (1.56-2.94)	2.74 (2.02-3.71)			
TC Plus[Fem:Tib]	16,264	70 (64 to 76)	45	0.67 (0.56-0.81)	1.76 (1.57-1.98)	2.34 (2.12-2.59)	3.45 (3.17-3.76)	4.59 (4.20-5.00)	*5.15 (4.61-5.75)*
Triathlon[Fem:Tib]	162,424	70 (63 to 76)	43	0.48 (0.45-0.52)	1.42 (1.36-1.49)	1.98 (1.91-2.06)	2.89 (2.77-3.03)	3.79 (3.42-4.19)	
Unity Knee[Fem] Unity[Tib]	1,599	70 (63 to 76)	45	0.33 (0.14-0.79)	0.85 (0.48-1.50)	1.29 (0.78-2.13)			
Vanguard[Fem:Tib]	88,536	70 (63 to 76)	42	0.40 (0.36-0.44)	1.40 (1.32-1.48)	1.99 (1.89-2.09)	2.92 (2.75-3.10)		
Vanguard[Fem] Maxim[Tib]	2,368	70 (62 to 76)	41	0.43 (0.23-0.80)	1.83 (1.34-2.52)	3.06 (2.37-3.95)	4.58 (3.68-5.69)	*5.17 (4.15-6.43)*	

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) KM estimates of cumulative revision (95% CI) in total knee replacement brands by whether a patella component was recorded. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	Patella status	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
All total knee replacements	**With Patella**	**495,816**	**70 (63 to 76)**	**38**	**0.41 (0.39-0.43)**	**1.24 (1.21-1.28)**	**1.80 (1.76-1.84)**	**2.82 (2.76-2.88)**	**3.87 (3.76-3.97)**	**4.49 (4.26-4.74)**
	Without Patella	**769,686**	**70 (63 to 76)**	**46**	**0.44 (0.42-0.45)**	**1.61 (1.58-1.64)**	**2.28 (2.24-2.32)**	**3.41 (3.36-3.46)**	**4.56 (4.48-4.65)**	**5.50 (5.28-5.72)**
ACS PC[Fem] ACS[Tib]	With Patella	94	68 (61 to 74)	29	*2.13 (0.54-8.24)*	*3.28 (1.07-9.83)*	*3.28 (1.07-9.83)*			
	Without Patella	1,077	68 (61 to 73)	52	0.65 (0.31-1.37)	2.57 (1.77-3.73)	3.18 (2.27-4.44)	4.40 (3.23-5.99)		
Advance MP Stature[Fem] Advance[Tib]	With Patella	508	69 (62 to 75)	12	0.00 (.-.)	0.60 (0.19-1.84)	1.57 (0.75-3.28)	*1.86 (0.93-3.71)*		
	Without Patella	999	69 (62 to 75)	14	0.10 (0.01-0.71)	2.26 (1.49-3.41)	3.23 (2.28-4.57)	4.00 (2.84-5.61)		
Advance MP[Fem] Advance[Tib]	With Patella	3,059	70 (63 to 76)	43	0.53 (0.32-0.86)	1.50 (1.12-2.00)	2.04 (1.58-2.63)	3.18 (2.54-3.98)	3.61 (2.83-4.59)	
	Without Patella	5,946	70 (64 to 76)	50	0.60 (0.43-0.83)	2.31 (1.95-2.73)	3.27 (2.84-3.78)	4.55 (3.99-5.19)	*5.36 (4.62-6.21)*	*9.00 (5.07-15.72)*
Advance PS[Fem] Advance[Tib]	With Patella	253	71 (66 to 76)	36	*1.20 (0.39-3.69)*	*4.19 (2.28-7.66)*	*5.15 (2.95-8.90)*	*8.60 (5.32-13.75)*	*10.94 (6.25-18.78)*	
	Without Patella	1,191	72 (66 to 78)	48	0.51 (0.23-1.13)	2.26 (1.54-3.30)	2.97 (2.12-4.15)	5.08 (3.73-6.89)	*6.35 (4.65-8.66)*	
AGC V2[Fem:Tib]	With Patella	12,200	71 (65 to 77)	35	0.25 (0.17-0.35)	1.24 (1.06-1.46)	1.84 (1.61-2.10)	2.99 (2.68-3.34)	4.56 (4.05-5.14)	*7.16 (5.51-9.30)*
	Without Patella	26,951	71 (65 to 77)	46	0.34 (0.28-0.42)	1.65 (1.50-1.81)	2.36 (2.18-2.55)	3.68 (3.45-3.93)	5.77 (5.39-6.17)	7.86 (6.91-8.94)
AGC[Fem] AGC V2[Tib]	With Patella	9,807	71 (64 to 77)	37	0.25 (0.17-0.37)	1.18 (0.98-1.41)	1.68 (1.44-1.96)	2.92 (2.57-3.33)	5.43 (4.68-6.29)	*5.91 (4.93-7.09)*
	Without Patella	19,143	71 (64 to 77)	45	0.33 (0.25-0.42)	1.78 (1.60-1.98)	2.50 (2.28-2.73)	3.82 (3.53-4.13)	5.11 (4.66-5.60)	*7.38 (6.01-9.05)*

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) (continued)

Brand[1]	Patella status	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
AS Columbus Cemented[Fem] Columbus CR/PS[Tib]	With Patella	984	66 (60 to 72)	53	0.33 (0.11-1.02)	1.76 (1.02-3.04)	2.58 (1.54-4.31)			
	Without Patella	669	66 (59 to 73)	54	0.66 (0.25-1.76)	1.70 (0.83-3.43)	*3.09 (1.62-5.85)*			
Attune[Fem] Attune FB[Tib]	With Patella	16,510	70 (63 to 76)	40	0.33 (0.25-0.43)	1.15 (0.98-1.35)	1.77 (1.52-2.06)			
	Without Patella	17,259	69 (62 to 76)	47	0.44 (0.35-0.56)	1.70 (1.50-1.93)	2.33 (2.07-2.61)			
Attune[Fem] Attune RP[Tib]	With Patella	3,759	69 (62 to 76)	41	0.28 (0.15-0.52)	0.84 (0.57-1.25)	1.13 (0.76-1.67)			
	Without Patella	2,011	70 (63 to 76)	50	0.23 (0.09-0.61)	1.05 (0.64-1.71)	1.80 (1.18-2.74)			
Columbus Cemented[Fem] Columbus CR/PS[Tib]	With Patella	4,991	70 (64 to 76)	36	0.64 (0.45-0.91)	1.31 (1.02-1.69)	1.74 (1.39-2.18)	3.13 (2.39-4.10)	*5.64 (3.64-8.70)*	
	Without Patella	11,693	71 (65 to 77)	45	0.36 (0.27-0.49)	1.48 (1.27-1.72)	2.09 (1.82-2.39)	2.99 (2.60-3.42)	*3.33 (2.86-3.88)*	
E-Motion Bicondylar Knee[Fem] E-Motion FP[Tib]	With Patella	299	66 (60 to 73)	33	1.03 (0.33-3.17)	5.60 (3.47-8.98)	*7.81 (5.21-11.62)*	*8.43 (5.65-12.49)*		
	Without Patella	3,079	68 (61 to 74)	46	0.62 (0.40-0.97)	2.00 (1.55-2.57)	2.85 (2.30-3.52)	3.99 (3.29-4.82)	*6.19 (4.59-8.32)*	
Endo-Model Standard Rotating Hinge[Fem:Tib]	With Patella	290	75.5 (68 to 82)	28	1.80 (0.75-4.28)	*3.19 (1.60-6.33)*	*4.75 (2.64-8.49)*	*6.58 (3.31-12.87)*		
	Without Patella	1,095	76 (69 to 83)	27	1.28 (0.75-2.20)	3.38 (2.40-4.75)	4.93 (3.67-6.62)	*7.14 (5.27-9.65)*	*8.31 (6.01-11.42)*	
EvolutionMP [Fem:Tib]	With Patella	856	72 (65 to 78)	46	0.63 (0.26-1.51)	1.33 (0.69-2.56)	*1.33 (0.69-2.56)*			
	Without Patella	1,232	68 (62 to 75)	45	0.34 (0.13-0.90)	1.50 (0.92-2.43)	1.96 (1.24-3.09)			
Genesis II Oxinium[Fem] Genesis II[Tib]	With Patella	6,464	59 (54 to 65)	37	0.49 (0.35-0.70)	1.69 (1.39-2.05)	2.35 (1.98-2.79)	4.26 (3.65-4.96)	*5.64 (4.65-6.83)*	
	Without Patella	5,365	59 (54 to 65)	43	0.66 (0.48-0.92)	3.05 (2.61-3.56)	4.65 (4.09-5.29)	7.83 (6.99-8.76)	9.31 (8.23-10.52)	
Genesis II[Fem:Tib]	With Patella	43,008	71 (65 to 77)	38	0.46 (0.40-0.53)	1.21 (1.11-1.32)	1.60 (1.47-1.73)	2.40 (2.21-2.60)	2.73 (2.46-3.03)	*2.94 (2.48-3.49)*
	Without Patella	47,531	71 (65 to 77)	46	0.47 (0.42-0.54)	1.67 (1.56-1.80)	2.35 (2.20-2.50)	3.42 (3.22-3.64)	3.93 (3.63-4.26)	*4.03 (3.68-4.41)*
Insall-Burstein II Microport[Fem] Insall-Burstein (Microport)[Tib]	With Patella	1,114	71 (65 to 77)	43	0.09 (0.01-0.64)	0.75 (0.37-1.49)	2.22 (1.48-3.33)	4.48 (3.34-6.01)	6.44 (4.96-8.35)	*7.05 (5.40-9.17)*
	Without Patella	917	71 (65 to 77)	48	0.66 (0.30-1.47)	2.93 (2.01-4.28)	3.75 (2.68-5.24)	5.89 (4.48-7.73)	7.73 (6.00-9.92)	*8.47 (6.53-10.95)*
Journey II BCS Oxinium[Fem] Journey[Tib]	With Patella	4,126	66 (59 to 73)	41	0.40 (0.24-0.66)	1.24 (0.90-1.70)	1.43 (1.04-1.95)			
	Without Patella	723	65 (57 to 72)	43	1.12 (0.56-2.22)	5.12 (3.70-7.07)	*6.14 (4.52-8.31)*			

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) (continued)

Brand[1]	Patella status	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
Kinemax [Fem:Tib]	With Patella	4,418	71 (64 to 77)	37	0.25 (0.14-0.45)	1.23 (0.94-1.61)	1.75 (1.39-2.19)	3.64 (3.09-4.29)	5.51 (4.77-6.36)	*5.82 (5.03-6.73)*
	Without Patella	6,633	71 (64 to 77)	47	0.24 (0.15-0.40)	2.04 (1.72-2.42)	3.27 (2.86-3.74)	5.37 (4.82-5.98)	7.60 (6.89-8.37)	*8.59 (7.61-9.69)*
LCS Complete[Fem] M.B.T.[Tib]	With Patella	1,509	69 (62 to 75)	33	0.54 (0.27-1.07)	1.93 (1.33-2.81)	3.17 (2.34-4.29)	4.83 (3.67-6.33)	*6.13 (4.55-8.23)*	
	Without Patella	28,417	70 (63 to 76)	45	0.42 (0.35-0.50)	1.66 (1.51-1.82)	2.44 (2.26-2.63)	3.55 (3.31-3.80)	4.30 (3.98-4.65)	
LCS[Fem:Tib]	With Patella	225	69 (63 to 76)	37	*1.33 (0.43-4.08)*	*4.53 (2.46-8.26)*	*5.01 (2.80-8.86)*	*5.54 (3.18-9.55)*	*6.98 (4.15-11.62)*	*6.98 (4.15-11.62)*
	Without Patella	1,862	70 (63 to 76)	42	0.54 (0.29-1.00)	1.37 (0.93-2.02)	1.89 (1.35-2.63)	2.55 (1.90-3.42)	3.23 (2.46-4.24)	*3.47 (2.65-4.55)*
Legion CR COCR[Fem] Genesis II[Tib]	With Patella	173	69 (62 to 76)	34	*1.18 (0.30-4.62)*	*2.37 (0.90-6.18)*	*3.01 (1.26-7.07)*			
	Without Patella	896	71 (66 to 78)	47	0.34 (0.11-1.06)	1.40 (0.80-2.46)	1.96 (1.20-3.19)			
Maxim[Fem:Tib]	With Patella	515	71 (63 to 76)	33	0.59 (0.19-1.82)	1.61 (0.81-3.20)	2.25 (1.25-4.03)	5.10 (3.33-7.77)	*7.18 (4.84-10.59)*	
	Without Patella	1,236	70 (63 to 77)	47	0.33 (0.12-0.87)	1.83 (1.21-2.77)	2.97 (2.14-4.11)	5.67 (4.43-7.24)	9.90 (7.97-12.28)	*16.77 (11.49-24.12)*
MRK[Fem:Tib]	With Patella	5,599	71 (64 to 77)	38	0.26 (0.15-0.43)	1.06 (0.81-1.39)	1.58 (1.26-1.98)	2.47 (2.00-3.06)	2.84 (2.23-3.60)	
	Without Patella	10,256	70 (64 to 76)	48	0.35 (0.25-0.49)	1.24 (1.03-1.48)	1.64 (1.39-1.92)	2.65 (2.26-3.10)	*2.95 (2.47-3.52)*	
Natural Knee II[Fem] NK2[Tib]	With Patella	1,540	70 (64 to 76)	41	0.46 (0.22-0.96)	1.72 (1.17-2.52)	2.70 (1.98-3.66)	4.31 (3.35-5.52)	*7.31 (5.67-9.39)*	
	Without Patella	1,284	70 (63 to 76)	42	0.16 (0.04-0.63)	0.96 (0.55-1.68)	1.70 (1.11-2.60)	3.56 (2.63-4.81)	*5.81 (4.38-7.69)*	*6.26 (4.65-8.40)*
Nexgen Hinge Type[Fem:Tib]	With Patella	450	73 (65 to 79)	26	1.17 (0.49-2.79)	2.44 (1.26-4.68)	*3.75 (2.10-6.66)*	*3.75 (2.10-6.66)*		
	Without Patella	606	73 (64 to 80)	27	1.20 (0.58-2.51)	2.84 (1.72-4.69)	3.99 (2.53-6.26)	*9.39 (6.08-14.35)*		
Nexgen LCCK[Fem] Nexgen[Tib]	With Patella	570	71 (63 to 78)	36	0.53 (0.17-1.65)	1.71 (0.85-3.41)	1.71 (0.85-3.41)	*4.95 (2.38-10.13)*		
	Without Patella	611	72 (64 to 80)	36	1.85 (1.03-3.31)	3.56 (2.31-5.47)	4.63 (3.10-6.90)	*5.02 (3.37-7.45)*	*9.81 (4.58-20.36)*	
Nexgen [Fem:Tib]	With Patella	54,617	70 (63 to 76)	37	0.41 (0.36-0.47)	1.29 (1.20-1.40)	2.07 (1.94-2.21)	3.65 (3.44-3.87)	4.77 (4.42-5.14)	*4.99 (4.56-5.45)*
	Without Patella	128,488	70 (64 to 76)	45	0.36 (0.33-0.40)	1.24 (1.18-1.31)	1.93 (1.85-2.01)	3.28 (3.15-3.41)	4.42 (4.19-4.65)	5.48 (4.76-6.30)
Nexgen[Fem] LPS (Legacy Posterior Stabilised ZimmerBiomet)[Tib]	With Patella	1,149	67 (59 to 74)	37	0.45 (0.19-1.07)	2.22 (1.49-3.29)	3.05 (2.17-4.29)	5.78 (4.41-7.56)	*7.82 (5.91-10.31)*	*7.82 (5.91-10.31)*
	Without Patella	2,170	67 (59 to 75)	51	0.46 (0.25-0.86)	1.65 (1.19-2.29)	2.32 (1.75-3.07)	3.43 (2.67-4.39)	*4.87 (3.72-6.36)*	*7.09 (4.74-10.55)*
Nexgen[Fem] TM Monoblock[Tib]	With Patella	416	62 (56 to 69)	56	0.73 (0.23-2.23)	2.46 (1.33-4.53)	3.25 (1.90-5.53)	*5.37 (3.49-8.23)*	*6.54 (4.23-10.04)*	
	Without Patella	3,870	64 (58 to 71)	57	0.60 (0.40-0.90)	2.62 (2.16-3.18)	3.28 (2.76-3.91)	4.24 (3.63-4.97)	5.10 (4.35-5.98)	*5.52 (4.60-6.60)*

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) (continued)

Brand[1]	Patella status	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
Optetrak CR[Fem] Optetrak[Tib]	With Patella	648	70 (64 to 76)	43	0.94 (0.42-2.07)	2.39 (1.45-3.93)	3.75 (2.51-5.59)	7.74 (5.75-10.39)	*11.52 (8.26-15.94)*	
	Without Patella	993	69 (63 to 76)	43	0.81 (0.41-1.62)	4.12 (3.04-5.58)	5.64 (4.35-7.30)	8.46 (6.79-10.53)	*10.18 (7.90-13.06)*	
Persona CR[Fem] Persona[Tib]	With Patella	3,305	69 (62 to 75)	40	0.38 (0.20-0.71)	0.63 (0.34-1.16)	*0.83 (0.43-1.62)*			
	Without Patella	4,401	70 (63 to 76)	49	0.29 (0.16-0.53)	0.92 (0.60-1.41)	1.72 (1.03-2.87)			
Persona PS[Fem] Persona[Tib]	With Patella	691	70 (62 to 76)	36	0.33 (0.08-1.33)	1.41 (0.67-2.98)	*2.75 (1.50-5.04)*			
	Without Patella	1,021	70 (64 to 76)	47	0.61 (0.28-1.36)	2.24 (1.43-3.50)	3.47 (2.31-5.20)			
PFC Sigma Bicondylar Knee[Fem] M.B.T.[Tib]	With Patella	8,848	65 (58 to 72)	43	0.44 (0.33-0.61)	1.69 (1.44-1.99)	2.38 (2.08-2.73)	3.48 (3.09-3.91)	4.48 (3.91-5.14)	*4.64 (4.00-5.37)*
	Without Patella	8,635	65 (58 to 73)	50	0.82 (0.65-1.03)	2.31 (2.01-2.65)	3.17 (2.82-3.57)	4.41 (3.97-4.90)	5.52 (4.91-6.19)	*5.52 (4.91-6.19)*
PFC Sigma Bicondylar Knee[Fem] PFC Bicondylar[Tib]	With Patella	69,639	71 (64 to 77)	38	0.36 (0.32-0.41)	1.07 (0.99-1.15)	1.51 (1.42-1.61)	2.13 (2.01-2.26)	2.77 (2.60-2.94)	3.39 (3.00-3.82)
	Without Patella	108,132	70 (64 to 76)	46	0.41 (0.37-0.45)	1.39 (1.32-1.47)	1.90 (1.81-1.99)	2.70 (2.59-2.81)	3.49 (3.34-3.65)	3.89 (3.63-4.16)
PFC Sigma Bicondylar Knee[Fem]PFC Sigma Bicondylar[Tib]	With Patella	87,727	71 (64 to 77)	38	0.37 (0.33-0.41)	1.15 (1.08-1.23)	1.65 (1.56-1.75)	2.28 (2.15-2.41)	*2.72 (2.37-3.12)*	
	Without Patella	114,110	70 (64 to 77)	45	0.38 (0.34-0.41)	1.55 (1.48-1.62)	2.14 (2.05-2.23)	2.84 (2.72-2.96)		
Profix Oxinium[Fem] Profix[Tib]	With Patella	42	61 (58 to 68)	26				*0.00 (.-.)*	*0.00 (.-.)*	
	Without Patella	958	61 (56 to 66)	44	0.84 (0.42-1.67)	3.06 (2.14-4.37)	3.38 (2.40-4.75)	4.73 (3.54-6.31)	5.80 (4.44-7.55)	*5.80 (4.44-7.55)*
Profix[Fem:Tib]	With Patella	83	73 (65 to 78)	30	*0.00 (.-.)*	*0.00 (.-.)*	*1.35 (0.19-9.21)*	*4.07 (1.33-12.10)*	*6.41 (2.36-16.77)*	
	Without Patella	3,894	73 (67 to 78)	44	0.42 (0.26-0.68)	1.40 (1.07-1.82)	1.87 (1.48-2.36)	2.67 (2.19-3.26)	3.51 (2.86-4.32)	*3.73 (2.98-4.66)*
Rotaglide + [Fem:Tib]	With Patella	1,182	69 (63 to 76)	42	0.85 (0.46-1.58)	2.69 (1.90-3.80)	3.50 (2.58-4.75)	6.18 (4.87-7.83)	8.48 (6.81-10.54)	*8.48 (6.81-10.54)*
	Without Patella	830	71 (64 to 77)	45	0.36 (0.12-1.12)	3.48 (2.41-4.99)	4.40 (3.18-6.07)	7.09 (5.45-9.19)	9.01 (7.04-11.49)	*9.01 (7.04-11.49)*
Rotaglide [Fem:Tib]	With Patella	1,430	71 (63 to 77)	39	0.49 (0.24-1.03)	2.37 (1.69-3.31)	4.00 (3.08-5.19)	4.65 (3.62-5.97)	*6.43 (4.89-8.43)*	
	Without Patella	19	67 (60 to 75)	37	*5.26 (0.76-31.88)*	*5.26 (0.76-31.88)*	*5.26 (0.76-31.88)*			
Saiph[Fem:Tib]	With Patella	1,373	69 (63 to 75)	36	0.73 (0.38-1.41)	0.99 (0.54-1.82)	1.16 (0.65-2.09)			
	Without Patella	1,043	69 (62 to 75)	51	0.46 (0.17-1.23)	1.68 (0.97-2.90)	*1.68 (0.97-2.90)*			
Scorpio NRG [Fem:Tib]	With Patella	7,128	71 (64 to 77)	39	0.45 (0.32-0.64)	1.29 (1.06-1.59)	1.98 (1.67-2.33)	3.13 (2.71-3.62)	*3.69 (3.12-4.36)*	
	Without Patella	6,983	70 (64 to 76)	46	0.37 (0.25-0.55)	1.88 (1.58-2.23)	2.85 (2.48-3.28)	4.14 (3.66-4.68)		
Scorpio [Fem:Tib]	With Patella	965	68 (60 to 75)	40	0.21 (0.05-0.84)	1.70 (1.04-2.76)	2.35 (1.56-3.55)	3.82 (2.74-5.32)	4.94 (3.52-6.91)	*7.66 (3.70-15.47)*

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) (continued)

Brand[1]	Patella status	N	Median (IQR) age at primary	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	18 years
	Without Patella	2,307	68 (62 to 75)	47	0.44 (0.23-0.81)	2.36 (1.80-3.07)	3.42 (2.74-4.27)	5.00 (4.15-6.02)	6.31 (5.25-7.57)	*8.11 (5.14-12.69)*
Scorpio[Fem] Scorpio NRG[Tib]	With Patella	8,149	71 (65 to 77)	38	0.32 (0.22-0.47)	1.34 (1.11-1.62)	2.04 (1.75-2.38)	3.25 (2.87-3.69)	4.25 (3.78-4.77)	*4.31 (3.83-4.85)*
	Without Patella	13,659	71 (64 to 77)	44	0.51 (0.40-0.64)	2.11 (1.88-2.37)	2.96 (2.68-3.26)	4.45 (4.10-4.82)	5.68 (5.24-6.15)	*6.38 (5.65-7.19)*
Sphere[Fem] GMK[Tib]	With Patella	577	68 (61 to 75)	37	1.23 (0.55-2.72)	*2.01 (1.04-3.85)*	*2.56 (1.32-4.93)*			
	Without Patella	1,615	69 (62 to 76)	45	1.00 (0.61-1.66)	2.15 (1.49-3.09)	2.76 (1.96-3.88)			
TC Plus[Fem:Tib]	With Patella	893	71 (64 to 76)	37	0.34 (0.11-1.04)	1.37 (0.78-2.39)	2.32 (1.50-3.58)	3.71 (2.58-5.32)	*4.87 (3.44-6.87)*	*5.52 (3.77-8.05)*
	Without Patella	15,371	70 (64 to 76)	45	0.69 (0.57-0.84)	1.78 (1.58-2.01)	2.34 (2.11-2.60)	3.44 (3.15-3.75)	4.57 (4.18-5.00)	*5.14 (4.57-5.77)*
Triathlon [Fem:Tib]	With Patella	73,292	70 (63 to 76)	39	0.48 (0.43-0.53)	1.22 (1.14-1.31)	1.71 (1.60-1.82)	2.55 (2.37-2.73)	*3.43 (2.88-4.08)*	
	Without Patella	89,132	70 (63 to 76)	47	0.49 (0.44-0.54)	1.58 (1.49-1.67)	2.20 (2.09-2.31)	3.17 (3.00-3.35)	*4.07 (3.60-4.60)*	
Unity Knee[Fem] Unity[Tib]	With Patella	1,202	70 (63 to 76)	43	0.26 (0.08-0.80)	0.84 (0.44-1.61)	1.23 (0.69-2.17)			
	Without Patella	397	69 (61 to 75)	49	0.55 (0.14-2.16)	*0.88 (0.28-2.72)*	*1.62 (0.55-4.74)*			
Vanguard [Fem:Tib]	With Patella	38,366	70 (63 to 76)	38	0.38 (0.32-0.45)	1.07 (0.97-1.19)	1.58 (1.45-1.73)	2.59 (2.29-2.93)		
	Without Patella	50,170	70 (63 to 76)	45	0.41 (0.36-0.47)	1.63 (1.51-1.75)	2.27 (2.13-2.42)	3.18 (2.96-3.41)		
Vanguard[Fem] Maxim[Tib]	With Patella	761	68 (60 to 75)	35	0.26 (0.07-1.06)	0.72 (0.26-1.97)	1.21 (0.53-2.74)	2.72 (1.48-4.95)	*3.18 (1.76-5.69)*	
	Without Patella	1,607	70 (62 to 76)	44	0.51 (0.25-1.01)	2.32 (1.66-3.24)	3.78 (2.89-4.94)	5.30 (4.20-6.68)	*5.93 (4.69-7.48)*	

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Tables 3.K7 (a) and (b) and Table 3.K8 show the Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any indication, of a primary TKR (Tables 3.K7 (a) and (b)) and primary UKR (Table 3.K8) by implant brand.

Table 3.K8 KM estimates of cumulative revision (95% CI) by unicompartmental knee replacement brands.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
All unicompartmental knee replacements	**153,369**	**63 (56 to 71)**	**50**	**1.01 (0.96-1.06)**	**3.61 (3.52-3.71)**	**5.55 (5.42-5.68)**	**10.57 (10.36-10.78)**	**15.93 (15.56-16.30)**	**18.79 (18.05-19.55)**
Unicondylar									
AMC/Uniglide [Fem:Tib]	3,026	64 (57 to 71)	51	2.35 (1.87-2.96)	6.03 (5.23-6.94)	7.68 (6.78-8.70)	12.72 (11.50-14.06)	*17.45 (15.62-19.48)*	
Journey Uni Oxinium[Fem] Journey Uni[Tib]	1,665	63 (56 to 70)	55	1.35 (0.88-2.06)	3.25 (2.43-4.34)	4.93 (3.78-6.43)	*5.89 (4.48-7.73)*		
MG Uni[Fem:Tib]	2,283	63 (57 to 70)	55	0.88 (0.57-1.36)	4.02 (3.29-4.91)	6.06 (5.15-7.13)	10.24 (9.04-11.60)	13.23 (11.79-14.82)	*14.28 (12.62-16.15)*
Oxford Cementless Partial Knee [Fem:Tib]	28,873	65 (58 to 72)	56	1.16 (1.04-1.29)	2.28 (2.10-2.48)	3.24 (2.99-3.49)	5.95 (5.32-6.65)		
Oxford Cementless Partial Knee[Fem] Oxford Partial Knee[Tib]	2,098	66 (58 to 74)	46	1.10 (0.73-1.67)	3.48 (2.73-4.44)	5.25 (4.25-6.46)	8.90 (7.31-10.82)	*12.33 (9.65-15.68)*	
Oxford Single Peg Cemented Partial Knee[Fem] Oxford Partial Knee[Tib]	43,403	64 (58 to 71)	52	1.22 (1.12-1.32)	4.35 (4.16-4.55)	6.46 (6.23-6.70)	11.52 (11.20-11.86)	16.89 (16.39-17.40)	19.91 (18.93-20.94)
Oxford Twin Peg Cemented Partial Knee[Fem] Oxford Partial Knee[Tib]	5,946	65 (57 to 72)	48	0.81 (0.60-1.08)	2.46 (2.08-2.92)	3.74 (3.23-4.33)	7.29 (6.30-8.44)	*11.50 (9.03-14.59)*	
Persona Partial Knee[Fem:Tib]	3,826	65 (58 to 72)	58	0.19 (0.09-0.43)	1.41 (0.92-2.15)				
*Physica ZUK [Fem:Tib]	21,737	63 (56 to 71)	55	0.35 (0.28-0.44)	1.77 (1.59-1.98)	2.76 (2.51-3.03)	5.79 (5.25-6.40)	*7.99 (6.61-9.63)*	
Preservation [Fem:Tib]	1,512	62 (56 to 69)	55	2.52 (1.84-3.45)	8.16 (6.88-9.67)	11.66 (10.12-13.40)	17.72 (15.85-19.79)	23.42 (21.22-25.80)	*25.41 (22.71-28.36)*
Restoris[Fem:Tib]	1,410	65 (58 to 73)	59	0.37 (0.14-0.99)	1.70 (0.97-2.95)	*1.70 (0.97-2.95)*			
Sigma HP (Uni)[Fem] Sigma HP[Tib]	14,147	63 (56 to 70)	58	0.70 (0.57-0.85)	2.76 (2.48-3.06)	3.86 (3.52-4.24)	6.58 (5.95-7.27)		
Triathlon Uni[Fem] Triathlon[Tib]	1,651	62 (56 to 70)	55	1.15 (0.73-1.82)	3.87 (3.00-4.99)	6.22 (5.00-7.73)	*7.89 (6.35-9.78)*		
Patellofemoral									
Avon[Fem]	6,685	58 (50 to 67)	22	0.66 (0.49-0.89)	4.09 (3.63-4.61)	7.24 (6.60-7.94)	14.55 (13.55-15.63)	21.35 (19.82-22.99)	*24.67 (22.05-27.54)*
FPV[Fem]	1,651	59 (52 to 68)	23	0.85 (0.50-1.43)	6.94 (5.81-8.29)	10.17 (8.79-11.75)	18.42 (16.49-20.56)		
Journey PFJ Oxinium[Fem]	2,290	58 (50 to 67)	23	1.85 (1.36-2.50)	7.25 (6.22-8.44)	12.29 (10.90-13.85)	20.98 (18.98-23.15)	*25.54 (22.64-28.73)*	
Sigma HP (PF)[Fem]	1,304	58 (50 to 66)	23	2.69 (1.94-3.73)	9.42 (7.95-11.14)	13.67 (11.90-15.68)	24.31 (21.56-27.34)		
Zimmer PFJ[Fem]	3,571	56 (49 to 65)	22	0.60 (0.39-0.93)	4.04 (3.39-4.81)	6.87 (5.95-7.93)	13.18 (11.41-15.20)		

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.

Table 3.K9 (a) shows Kaplan-Meier estimates of the cumulative percentage probability of first revision of a primary TKR or primary UKR by implant brand and bearing / constraint type for those brands / bearing types which were implanted on at least 1,000 occasions for UKR and 2,500 occasions for TKR. Patient summaries of age and gender by brand are also given.

Table 3.K9 (a) KM estimates of cumulative revision (95% CI) by fixation, constraint and brand. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Total knee replacements									
AGC V2[Fem:Tib]									
Cemented, unconstrained, fixed	37,202	71 (65 to 77)	43	0.27 (0.22-0.32)	1.43 (1.31-1.55)	2.09 (1.94-2.24)	3.31 (3.12-3.51)	5.22 (4.90-5.55)	7.52 (6.64-8.51)
AGC[Fem]AGC V2[Tib]									
Cemented, unconstrained, fixed	28,217	71 (64 to 77)	42	0.31 (0.25-0.38)	1.57 (1.43-1.72)	2.21 (2.04-2.39)	3.46 (3.23-3.71)	5.32 (4.88-5.78)	*6.70 (5.80-7.72)*
Advance MP[Fem]Advance[Tib]									
Cemented, unconstrained, fixed	8,826	70 (64 to 76)	48	0.56 (0.42-0.74)	1.98 (1.71-2.30)	2.74 (2.41-3.11)	3.99 (3.55-4.49)	4.64 (4.08-5.28)	*5.97 (4.29-8.27)*
Attune CR Cemented[Fem]Attune FB[Tib]									
Cemented, unconstrained, fixed	22,308	69 (62 to 76)	44	0.37 (0.29-0.46)	1.36 (1.19-1.54)	1.87 (1.66-2.11)			
Attune CR Cemented[Fem]Attune RP[Tib]									
Cemented, unconstrained, mobile	4,245	70 (63 to 77)	43	0.25 (0.14-0.47)	0.90 (0.63-1.31)	1.38 (0.97-1.97)			
Attune PS Cemented[Fem]Attune FB[Tib]									
Cemented, posterior-stabilised, fixed	11,445	70 (63 to 76)	42	0.42 (0.31-0.56)	1.60 (1.36-1.88)	2.43 (2.10-2.82)			
Columbus Cemented[Fem]Columbus CR/PS[Tib]									
Cemented, unconstrained, fixed	13,538	70 (64 to 76)	43	0.44 (0.34-0.57)	1.42 (1.23-1.64)	1.97 (1.73-2.23)	2.92 (2.56-3.32)	*3.64 (3.08-4.31)*	
Cemented, constrained condylar	2,782	71 (65 to 77)	39	0.53 (0.31-0.89)	1.47 (1.06-2.05)	2.01 (1.47-2.76)			
Genesis II Oxinium[Fem]Genesis II[Tib]									
Cemented, unconstrained, fixed	7,964	59 (55 to 65)	40	0.55 (0.41-0.75)	2.02 (1.72-2.36)	2.94 (2.56-3.36)	4.85 (4.29-5.49)	6.36 (5.52-7.32)	
Cemented, posterior-stabilised, fixed	3,608	58 (53 to 64)	41	0.62 (0.41-0.94)	3.04 (2.51-3.68)	4.62 (3.94-5.42)	8.48 (7.39-9.73)	*9.74 (8.32-11.40)*	
Genesis II[Fem:Tib]									
Cemented, unconstrained, fixed	65,660	71 (65 to 77)	43	0.40 (0.35-0.45)	1.31 (1.22-1.41)	1.79 (1.69-1.91)	2.65 (2.49-2.82)	2.97 (2.76-3.19)	*3.15 (2.83-3.49)*
Cemented, posterior-stabilised, fixed	23,090	71 (65 to 77)	40	0.65 (0.56-0.77)	1.77 (1.60-1.96)	2.46 (2.25-2.69)	3.68 (3.37-4.03)	*4.71 (3.90-5.68)*	
Journey II BCS Oxinium[Fem]Journey[Tib]									
Cemented, posterior-stabilised, fixed	4,840	66 (59 to 73)	41	0.52 (0.34-0.78)	1.97 (1.57-2.48)	2.36 (1.89-2.95)			

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Kinemax[Fem:Tib]									
Cemented, unconstrained, fixed	10,902	71 (64 to 77)	43	0.24 (0.16-0.35)	1.72 (1.49-1.99)	2.65 (2.36-2.98)	4.66 (4.25-5.10)	6.69 (6.17-7.26)	7.40 (6.74-8.13)
LCS Complete[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile	12,652	70 (64 to 76)	41	0.41 (0.31-0.54)	1.52 (1.32-1.76)	2.50 (2.23-2.81)	4.01 (3.64-4.42)	4.63 (4.18-5.14)	
Uncemented, unconstrained, mobile	16,329	69 (62 to 75)	47	0.41 (0.32-0.52)	1.79 (1.59-2.01)	2.46 (2.22-2.72)	3.32 (3.03-3.65)	4.13 (3.70-4.60)	
MRK[Fem:Tib]									
Cemented, unconstrained, fixed	15,577	70 (64 to 76)	44	0.31 (0.23-0.41)	1.16 (1.00-1.35)	1.60 (1.40-1.83)	2.58 (2.27-2.93)	2.92 (2.52-3.39)	*3.24 (2.57-4.08)*
Natural Knee II[Fem]NK2[Tib]									
Cemented, unconstrained, fixed	2,693	70 (64 to 76)	41	0.34 (0.18-0.65)	1.44 (1.05-1.97)	2.23 (1.73-2.88)	3.83 (3.13-4.68)	6.39 (5.24-7.78)	*6.65 (5.42-8.15)*
Nexgen[Fem:Tib]									
Cemented, unconstrained, fixed	94,746	70 (63 to 76)	43	0.31 (0.28-0.35)	1.01 (0.95-1.08)	1.48 (1.40-1.57)	2.38 (2.25-2.52)	3.15 (2.91-3.41)	*3.87 (3.01-4.97)*
Cemented, posterior-stabilised, fixed	85,503	70 (64 to 77)	41	0.45 (0.40-0.50)	1.52 (1.44-1.61)	2.49 (2.38-2.60)	4.37 (4.19-4.55)	5.76 (5.48-6.05)	6.55 (5.92-7.25)
Nexgen[Fem]TM Monoblock[Tib]									
Uncemented, unconstrained, fixed	4,012	64 (58 to 71)	58	0.60 (0.40-0.90)	2.58 (2.13-3.13)	3.28 (2.76-3.89)	4.37 (3.75-5.09)	5.19 (4.45-6.06)	*5.59 (4.70-6.64)*
PFC Sigma Bicondylar Knee[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile	8,466	64 (58 to 72)	47	0.58 (0.44-0.77)	1.89 (1.62-2.21)	2.65 (2.32-3.02)	3.83 (3.42-4.29)	5.11 (4.49-5.83)	*5.27 (4.58-6.05)*
Cemented, posterior-stabilised, mobile	7,230	65 (59 to 72)	46	0.66 (0.49-0.87)	2.17 (1.86-2.54)	2.99 (2.62-3.42)	4.18 (3.72-4.70)	4.98 (4.39-5.64)	*4.98 (4.39-5.64)*
PFC Sigma Bicondylar Knee[Fem]PFC Bicondylar[Tib]									
Cemented, unconstrained, fixed	138,741	70 (64 to 76)	43	0.39 (0.36-0.42)	1.21 (1.15-1.27)	1.66 (1.59-1.73)	2.32 (2.23-2.41)	2.96 (2.83-3.09)	3.31 (3.12-3.52)
Cemented, posterior-stabilised, fixed	37,294	71 (64 to 77)	41	0.39 (0.34-0.46)	1.47 (1.35-1.60)	2.04 (1.90-2.19)	2.96 (2.78-3.16)	3.91 (3.66-4.17)	4.78 (4.17-5.48)
PFC Sigma Bicondylar Knee[Fem]PFC Sigma Bicondylar[Tib]									
Cemented, unconstrained, fixed	129,225	70 (63 to 76)	42	0.35 (0.32-0.38)	1.30 (1.24-1.37)	1.84 (1.76-1.92)	2.46 (2.36-2.57)		
Cemented, posterior-stabilised, fixed	57,029	71 (64 to 77)	42	0.43 (0.38-0.48)	1.59 (1.48-1.70)	2.20 (2.07-2.33)	3.02 (2.86-3.20)		
Cemented, monobloc polyethylene tibia	14,978	74 (69 to 79)	42	0.34 (0.26-0.45)	1.23 (1.06-1.43)	1.62 (1.41-1.85)	1.99 (1.73-2.29)	*2.05 (1.77-2.38)*	
Persona CR[Fem]Persona[Tib]									
Cemented, unconstrained, fixed	6,903	70 (62 to 76)	45	0.33 (0.21-0.52)	0.82 (0.57-1.17)	1.30 (0.84-2.01)			

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[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Scorpio NRG[Fem:Tib]									
Cemented, unconstrained, fixed	8,594	70 (64 to 76)	42	0.36 (0.25-0.51)	1.44 (1.21-1.72)	2.36 (2.05-2.71)	3.48 (3.08-3.94)		
Cemented, posterior-stabilised, fixed	4,735	70 (63 to 77)	43	0.45 (0.29-0.68)	1.70 (1.37-2.12)	2.40 (1.99-2.88)	3.82 (3.28-4.46)	*4.25 (3.59-5.03)*	
Scorpio[Fem]Scorpio NRG[Tib]									
Cemented, unconstrained, fixed	10,515	71 (64 to 77)	42	0.44 (0.33-0.59)	1.84 (1.59-2.11)	2.57 (2.28-2.89)	3.86 (3.50-4.27)	5.09 (4.62-5.61)	*5.28 (4.77-5.84)*
Cemented, posterior-stabilised, fixed	6,085	72 (65 to 77)	40	0.22 (0.13-0.37)	1.66 (1.36-2.02)	2.57 (2.19-3.01)	4.15 (3.65-4.71)	5.42 (4.82-6.10)	*5.91 (5.15-6.77)*
Uncemented, unconstrained, fixed	3,755	70 (64 to 76)	47	0.62 (0.41-0.93)	1.92 (1.52-2.41)	2.59 (2.13-3.16)	3.91 (3.32-4.61)	4.68 (4.00-5.48)	*6.05 (4.12-8.85)*
TC Plus[Fem:Tib]									
Cemented, unconstrained, fixed	7,942	70 (64 to 76)	46	0.81 (0.63-1.03)	2.00 (1.72-2.34)	2.63 (2.30-3.01)	3.73 (3.33-4.19)	4.90 (4.36-5.50)	*5.41 (4.70-6.23)*
Cemented, unconstrained, mobile	5,461	70 (64 to 76)	44	0.51 (0.36-0.74)	1.48 (1.19-1.85)	2.00 (1.65-2.41)	3.09 (2.64-3.62)	3.92 (3.36-4.57)	
Triathlon[Fem:Tib]									
Cemented, unconstrained, fixed	127,793	70 (63 to 76)	43	0.45 (0.41-0.48)	1.34 (1.27-1.41)	1.86 (1.78-1.95)	2.76 (2.62-2.91)	*3.54 (3.16-3.98)*	
Cemented, posterior-stabilised, fixed	26,763	70 (63 to 77)	41	0.62 (0.53-0.72)	1.72 (1.56-1.89)	2.46 (2.26-2.68)	3.46 (3.16-3.78)		
Uncemented, unconstrained, fixed	5,038	68 (61 to 75)	51	0.59 (0.41-0.87)	1.79 (1.41-2.25)	2.15 (1.71-2.71)	2.76 (2.06-3.70)		
Vanguard[Fem:Tib]									
Cemented, unconstrained, fixed	71,987	70 (64 to 76)	42	0.36 (0.32-0.41)	1.31 (1.23-1.40)	1.89 (1.78-2.01)	2.79 (2.60-2.98)		
Cemented, posterior-stabilised, fixed	10,993	70 (63 to 77)	40	0.62 (0.49-0.79)	2.08 (1.81-2.38)	2.84 (2.51-3.21)	4.20 (3.61-4.88)		
Cemented, constrained condylar	4,126	70 (63 to 76)	36	0.48 (0.30-0.76)	1.25 (0.92-1.70)	1.54 (1.15-2.06)	*1.81 (1.34-2.46)*		
Unicondylar knee replacements									
AMC/Uniglide[Fem:Tib]									
Cemented, monobloc polyethylene tibia	1,087	67 (59 to 75)	50	0.28 (0.09-0.86)	2.99 (2.12-4.20)	4.61 (3.49-6.07)	8.08 (6.44-10.10)	*11.67 (9.25-14.68)*	
Journey Uni Oxinium[Fem]Journey Uni[Tib]									
Cemented, fixed	1,500	63 (56 to 70)	53	1.50 (0.98-2.29)	3.01 (2.19-4.13)	4.38 (3.24-5.89)			
MG Uni[Fem:Tib]									
Cemented, fixed	1,501	62 (56 to 69)	55	1.00 (0.60-1.65)	4.37 (3.44-5.54)	6.57 (5.42-7.96)	11.37 (9.82-13.14)	14.35 (12.54-16.41)	*15.40 (13.30-17.80)*
Oxford Cementless Partial Knee[Fem:Tib]									
Uncemented/Hybrid, mobile	28,873	65 (58 to 72)	56	1.16 (1.04-1.29)	2.28 (2.10-2.48)	3.24 (2.99-3.49)	5.95 (5.32-6.65)		

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[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Oxford Cementless Partial Knee[Fem]Oxford Partial Knee[Tib]									
Uncemented/Hybrid, mobile	1,571	65 (58 to 73)	50	1.43 (0.94-2.17)	4.17 (3.26-5.33)	5.82 (4.70-7.19)	9.47 (7.80-11.47)	*12.87 (10.16-16.24)*	
Oxford Single Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	43,376	64 (58 to 71)	52	1.21 (1.11-1.32)	4.35 (4.16-4.55)	6.46 (6.23-6.70)	11.53 (11.20-11.86)	16.89 (16.39-17.40)	19.91 (18.93-20.94)
Oxford Twin Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	5,660	65 (57 to 72)	49	0.77 (0.57-1.04)	2.45 (2.05-2.92)	3.77 (3.24-4.37)	7.29 (6.29-8.44)	*11.50 (9.03-14.60)*	
Persona Partial Knee[Fem:Tib]									
Cemented, fixed	3,826	65 (58 to 72)	58	0.19 (0.09-0.43)	1.41 (0.92-2.15)				
***Physica ZUK[Fem:Tib]**									
Cemented, fixed	19,566	63 (56 to 71)	55	0.37 (0.29-0.47)	1.64 (1.45-1.85)	2.58 (2.32-2.86)	5.51 (4.93-6.16)	*7.78 (6.36-9.51)*	
Cemented, monobloc polyethylene tibia	2,171	64 (56 to 71)	56	0.20 (0.07-0.53)	2.86 (2.20-3.71)	4.14 (3.30-5.18)	7.73 (6.26-9.53)		
Restoris[Fem:Tib]									
Cemented, fixed	1,410	65 (58 to 73)	59	0.37 (0.14-0.99)	1.70 (0.97-2.95)	*1.70 (0.97-2.95)*			
Sigma HP (Uni)[Fem]Sigma HP[Tib]									
Cemented, fixed	13,836	63 (56 to 70)	58	0.71 (0.58-0.87)	2.68 (2.41-2.99)	3.74 (3.40-4.12)	6.41 (5.77-7.11)		
Triathlon Uni[Fem]Triathlon[Tib]									
Cemented, fixed	1,651	62 (56 to 70)	55	1.15 (0.73-1.82)	3.87 (3.00-4.99)	6.22 (5.00-7.73)	*7.89 (6.35-9.78)*		
Patellofemoral knee replacements									
Avon[Fem]									
Patellofemoral	6,685	58 (50 to 67)	22	0.66 (0.49-0.89)	4.09 (3.63-4.61)	7.24 (6.60-7.94)	14.55 (13.55-15.63)	21.35 (19.82-22.99)	*24.67 (22.05-27.54)*
FPV[Fem]									
Patellofemoral	1,651	59 (52 to 68)	23	0.85 (0.50-1.43)	6.94 (5.81-8.29)	10.17 (8.79-11.75)	18.42 (16.49-20.56)		
Journey PFJ Oxinium[Fem]									
Patellofemoral	2,290	58 (50 to 67)	23	1.85 (1.36-2.50)	7.25 (6.22-8.44)	12.29 (10.90-13.85)	20.98 (18.98-23.15)	*25.54 (22.64-28.73)*	
Sigma HP (PF)[Fem]									
Patellofemoral	1,304	58 (50 to 66)	23	2.69 (1.94-3.73)	9.42 (7.95-11.14)	13.67 (11.90-15.68)	24.31 (21.56-27.34)		
Zimmer PFJ[Fem]									
Patellofemoral	3,571	56 (49 to 65)	22	0.60 (0.39-0.93)	4.04 (3.39-4.81)	6.87 (5.95-7.93)	13.18 (11.41-15.20)		

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[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) KM estimates of cumulative revision (95% CI) by fixation, constraint, brand and whether a patella component was recorded. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Total knee replacements									
AGC V2[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	11,810	71 (65 to 77)	35	0.23 (0.16-0.34)	1.22 (1.03-1.43)	1.81 (1.58-2.07)	2.95 (2.63-3.30)	4.53 (4.01-5.12)	*7.19 (5.50-9.36)*
Cemented, unconstrained, fixed, without patella	25,392	71 (65 to 77)	46	0.28 (0.22-0.36)	1.52 (1.38-1.68)	2.22 (2.04-2.41)	3.48 (3.24-3.73)	5.50 (5.12-5.92)	7.68 (6.68-8.82)
AGC[Fem]AGC V2[Tib]									
Cemented, unconstrained, fixed, with patella	9,555	71 (64 to 77)	37	0.25 (0.17-0.38)	1.19 (0.99-1.43)	1.69 (1.45-1.98)	2.93 (2.57-3.34)	5.56 (4.78-6.46)	*6.06 (5.04-7.29)*
Cemented, unconstrained, fixed, without patella	18,662	71 (64 to 77)	45	0.33 (0.26-0.43)	1.76 (1.58-1.97)	2.48 (2.26-2.72)	3.73 (3.44-4.04)	5.04 (4.58-5.54)	*7.16 (5.80-8.82)*
Advance MP[Fem]Advance[Tib]									
Cemented, unconstrained, fixed, with patella	3,012	70 (63 to 76)	43	0.50 (0.30-0.83)	1.46 (1.08-1.96)	1.97 (1.52-2.55)	3.13 (2.49-3.93)	3.56 (2.78-4.54)	
Cemented, unconstrained, fixed, without patella	5,814	70 (64 to 76)	50	0.59 (0.42-0.83)	2.26 (1.90-2.68)	3.14 (2.71-3.64)	4.43 (3.87-5.07)	*5.27 (4.52-6.13)*	*8.94 (5.00-15.72)*
Attune CR Cemented[Fem]Attune FB[Tib]									
Cemented, unconstrained, fixed, with patella	9,393	70 (63 to 76)	39	0.25 (0.16-0.38)	1.07 (0.85-1.34)	1.59 (1.28-1.96)			
Cemented, unconstrained, fixed, without patella	12,915	69 (62 to 76)	48	0.45 (0.34-0.59)	1.55 (1.33-1.80)	2.06 (1.78-2.38)			
Attune CR Cemented[Fem]Attune RP[Tib]									
Cemented, unconstrained, mobile, with patella	2,559	70 (63 to 77)	38	0.33 (0.17-0.66)	0.95 (0.60-1.49)	1.19 (0.75-1.88)			
Cemented, unconstrained, mobile, without patella	1,686	70 (63 to 77)	49	0.13 (0.03-0.53)	0.84 (0.45-1.56)	1.62 (0.95-2.78)			
Attune PS Cemented[Fem]Attune FB[Tib]									
Cemented, posterior-stabilised, fixed, with patella	7,111	70 (63 to 76)	41	0.42 (0.29-0.61)	1.25 (0.99-1.57)	2.00 (1.61-2.48)			
Cemented, posterior-stabilised, fixed, without patella	4,334	70 (62 to 76)	44	0.42 (0.26-0.67)	2.14 (1.71-2.66)	3.10 (2.53-3.79)			
Columbus Cemented[Fem]Columbus CR/PS[Tib]									
Cemented, unconstrained, fixed, with patella	4,090	70 (64 to 76)	37	0.61 (0.41-0.90)	1.25 (0.95-1.66)	1.61 (1.25-2.08)	2.97 (2.21-3.98)	*5.54 (3.50-8.70)*	

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[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Cemented, unconstrained, fixed, without patella	9,448	71 (65 to 76)	46	0.37 (0.26-0.51)	1.49 (1.26-1.77)	2.11 (1.82-2.44)	2.94 (2.55-3.40)	*3.30 (2.81-3.88)*	
Cemented, constrained condylar, with patella	770	70 (64 to 76)	34	0.94 (0.45-1.97)	1.86 (1.08-3.18)	*2.56 (1.47-4.45)*			
Cemented, constrained condylar, without patella	2,012	71 (65 to 78)	41	0.37 (0.18-0.77)	1.32 (0.87-2.01)	1.80 (1.22-2.64)			
Genesis II Oxinium[Fem]Genesis II[Tib]									
Cemented, unconstrained, fixed, with patella	4,539	59 (55 to 65)	38	0.50 (0.33-0.76)	1.46 (1.14-1.87)	2.00 (1.61-2.50)	3.67 (3.01-4.46)	*5.09 (3.98-6.49)*	
Cemented, unconstrained, fixed, without patella	3,425	59 (54 to 65)	43	0.62 (0.41-0.96)	2.73 (2.22-3.35)	4.11 (3.45-4.88)	6.33 (5.41-7.41)	7.96 (6.73-9.41)	
Cemented, posterior-stabilised, fixed, with patella	1,807	59 (54 to 66)	35	0.51 (0.27-0.98)	2.31 (1.69-3.17)	3.30 (2.51-4.33)	5.93 (4.62-7.58)	*7.28 (5.29-9.98)*	
Cemented, posterior-stabilised, fixed, without patella	1,801	57 (52 to 63)	47	0.73 (0.42-1.25)	3.73 (2.93-4.74)	5.85 (4.81-7.12)	10.67 (9.06-12.55)	*11.90 (9.94-14.21)*	
Genesis II[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	30,311	71 (66 to 77)	39	0.38 (0.32-0.46)	1.00 (0.89-1.13)	1.32 (1.19-1.47)	1.99 (1.79-2.21)	2.27 (1.99-2.58)	*2.51 (2.01-3.13)*
Cemented, unconstrained, fixed, without patella	35,349	71 (65 to 77)	46	0.41 (0.35-0.49)	1.56 (1.43-1.70)	2.16 (2.01-2.33)	3.16 (2.94-3.40)	3.50 (3.21-3.80)	*3.63 (3.26-4.04)*
Cemented, posterior-stabilised, fixed, with patella	12,418	71 (65 to 77)	36	0.65 (0.52-0.81)	1.68 (1.46-1.94)	2.22 (1.94-2.53)	3.44 (3.01-3.94)	*3.99 (3.30-4.82)*	
Cemented, posterior-stabilised, fixed, without patella	10,672	71 (65 to 77.5)	44	0.65 (0.51-0.83)	1.86 (1.61-2.14)	2.70 (2.39-3.06)	3.92 (3.47-4.42)	*5.18 (4.05-6.60)*	
Journey II BCS Oxinium[Fem]Journey[Tib]									
Cemented, posterior-stabilised, fixed, with patella	4,119	66 (59 to 73)	41	0.40 (0.24-0.66)	1.24 (0.91-1.71)	1.43 (1.04-1.95)			
Cemented, posterior-stabilised, fixed, without patella	721	65 (57 to 72)	43	1.12 (0.56-2.22)	4.99 (3.59-6.92)	*6.01 (4.41-8.18)*			
Kinemax[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	4,328	71 (64 to 77)	37	0.26 (0.14-0.46)	1.23 (0.94-1.62)	1.73 (1.38-2.18)	3.60 (3.05-4.25)	5.44 (4.70-6.28)	*5.75 (4.96-6.65)*
Cemented, unconstrained, fixed, without patella	6,574	71 (64 to 77)	47	0.23 (0.14-0.38)	2.04 (1.72-2.42)	3.25 (2.84-3.72)	5.35 (4.80-5.96)	7.52 (6.81-8.29)	*8.52 (7.54-9.62)*

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
LCS Complete[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile, with patella	804	70 (63 to 77)	31	0.63 (0.26-1.50)	2.09 (1.28-3.39)	3.60 (2.46-5.25)	6.23 (4.51-8.58)	*7.33 (5.20-10.30)*	
Cemented, unconstrained, mobile, without patella	11,848	71 (64 to 76)	42	0.39 (0.30-0.53)	1.48 (1.28-1.72)	2.43 (2.16-2.74)	3.87 (3.49-4.29)	4.46 (4.00-4.97)	
Uncemented, unconstrained, mobile, with patella	613	68 (61 to 74)	34	0.50 (0.16-1.53)	1.66 (0.86-3.18)	2.39 (1.35-4.20)	*2.69 (1.56-4.65)*	*3.53 (1.89-6.55)*	
Uncemented, unconstrained, mobile, without patella	15,716	69 (63 to 75)	47	0.41 (0.32-0.52)	1.79 (1.59-2.02)	2.46 (2.22-2.73)	3.34 (3.04-3.67)	4.14 (3.71-4.62)	
MRK[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	5,524	71 (64 to 77)	38	0.24 (0.14-0.42)	1.02 (0.77-1.34)	1.54 (1.22-1.94)	2.44 (1.97-3.03)	2.80 (2.20-3.57)	
Cemented, unconstrained, fixed, without patella	10,053	70 (64 to 76)	48	0.35 (0.25-0.49)	1.24 (1.03-1.48)	1.63 (1.39-1.92)	2.65 (2.26-3.10)	*2.95 (2.47-3.52)*	
Natural Knee II[Fem]NK2[Tib]									
Cemented, unconstrained, fixed, with patella	1,526	70 (64 to 77)	41	0.46 (0.22-0.96)	1.74 (1.19-2.54)	2.72 (2.00-3.69)	4.35 (3.39-5.58)	*7.28 (5.63-9.39)*	
Cemented, unconstrained, fixed, without patella	1,167	70 (64 to 76)	40	0.17 (0.04-0.69)	1.05 (0.60-1.85)	1.59 (1.01-2.52)	3.15 (2.24-4.41)	*5.28 (3.85-7.21)*	*5.81 (4.15-8.10)*
Nexgen[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	25,933	70 (63 to 76)	38	0.32 (0.25-0.40)	0.98 (0.86-1.11)	1.43 (1.27-1.60)	2.40 (2.15-2.68)	3.24 (2.75-3.81)	*3.24 (2.75-3.81)*
Cemented, unconstrained, fixed, without patella	68,813	70 (64 to 76)	45	0.31 (0.27-0.36)	1.03 (0.95-1.11)	1.50 (1.41-1.61)	2.37 (2.23-2.53)	3.11 (2.84-3.41)	*4.12 (2.96-5.72)*
Cemented, posterior-stabilised, fixed, with patella	27,834	70 (64 to 76)	36	0.51 (0.43-0.60)	1.60 (1.45-1.76)	2.67 (2.47-2.88)	4.71 (4.39-5.06)	6.03 (5.55-6.56)	*6.34 (5.75-6.98)*
Cemented, posterior-stabilised, fixed, without patella	57,669	71 (64 to 77)	43	0.42 (0.37-0.48)	1.49 (1.39-1.59)	2.40 (2.27-2.54)	4.21 (4.01-4.42)	5.64 (5.30-6.00)	*6.65 (5.79-7.64)*
Nexgen[Fem]TM Monoblock[Tib]									
Uncemented, unconstrained, fixed, with patella	379	63 (57 to 69)	58	0.53 (0.13-2.11)	2.17 (1.09-4.30)	3.03 (1.69-5.41)	*5.03 (3.14-7.99)*	*6.32 (3.94-10.06)*	
Uncemented, unconstrained, fixed, without patella	3,633	65 (58 to 72)	58	0.61 (0.40-0.92)	2.62 (2.15-3.20)	3.30 (2.76-3.95)	4.30 (3.66-5.05)	5.09 (4.32-5.99)	*5.51 (4.58-6.63)*

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
PFC Sigma Bicondylar Knee[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile, with patella	3,233	64 (58 to 72)	41	0.47 (0.28-0.78)	2.09 (1.65-2.66)	2.87 (2.33-3.52)	4.29 (3.61-5.09)	5.97 (4.88-7.29)	
Cemented, unconstrained, mobile, without patella	5,233	64 (58 to 71)	51	0.65 (0.47-0.91)	1.77 (1.44-2.17)	2.52 (2.12-2.99)	3.54 (3.04-4.12)	4.53 (3.82-5.37)	
Cemented, posterior-stabilised, mobile, with patella	5,217	64 (59 to 72)	45	0.44 (0.30-0.67)	1.44 (1.15-1.81)	2.08 (1.72-2.51)	2.98 (2.53-3.51)	3.46 (2.90-4.13)	
Cemented, posterior-stabilised, mobile, without patella	2,013	66 (58 to 73)	49	1.20 (0.81-1.79)	4.07 (3.28-5.04)	5.37 (4.45-6.47)	7.32 (6.20-8.63)	8.71 (7.34-10.31)	
PFC Sigma Bicondylar Knee[Fem]PFC Bicondylar[Tib]									
Cemented, unconstrained, fixed, with patella	46,960	71 (64 to 76)	38	0.34 (0.29-0.40)	0.99 (0.90-1.09)	1.44 (1.32-1.56)	2.00 (1.86-2.16)	2.62 (2.42-2.84)	3.05 (2.69-3.45)
Cemented, unconstrained, fixed, without patella	91,781	70 (64 to 76)	46	0.41 (0.37-0.46)	1.31 (1.24-1.39)	1.77 (1.69-1.87)	2.48 (2.37-2.60)	3.13 (2.97-3.29)	3.43 (3.21-3.67)
Cemented, posterior-stabilised, fixed, with patella	22,046	71 (64 to 77)	39	0.40 (0.32-0.49)	1.21 (1.07-1.36)	1.66 (1.49-1.84)	2.36 (2.15-2.59)	3.02 (2.75-3.32)	3.97 (3.17-4.95)
Cemented, posterior-stabilised, fixed, without patella	15,248	71 (64 to 77)	45	0.39 (0.30-0.51)	1.85 (1.64-2.08)	2.59 (2.34-2.86)	3.82 (3.50-4.17)	5.19 (4.74-5.68)	*5.94 (5.05-6.99)*
PFC Sigma Bicondylar Knee[Fem]PFC Sigma Bicondylar[Tib]									
Cemented, unconstrained, fixed, with patella	46,797	70 (63 to 76)	37	0.35 (0.30-0.41)	1.13 (1.03-1.23)	1.62 (1.50-1.75)	2.18 (2.01-2.36)		
Cemented, unconstrained, fixed, without patella	82,428	70 (63 to 76)	46	0.35 (0.31-0.39)	1.39 (1.31-1.48)	1.96 (1.86-2.06)	2.61 (2.47-2.74)		
Cemented, posterior-stabilised, fixed, with patella	37,891	71 (65 to 77)	40	0.39 (0.33-0.46)	1.20 (1.09-1.32)	1.70 (1.56-1.84)	2.40 (2.21-2.60)		
Cemented, posterior-stabilised, fixed, without patella	19,138	70 (63 to 77)	45	0.50 (0.41-0.61)	2.33 (2.12-2.56)	3.15 (2.90-3.42)	4.19 (3.87-4.53)		
Cemented, monobloc polyethylene tibia, with patella	2,917	76 (71 to 81)	37	0.39 (0.22-0.70)	1.02 (0.70-1.49)	1.50 (1.08-2.08)	1.75 (1.26-2.41)	*1.94 (1.36-2.75)*	
Cemented, monobloc polyethylene tibia, without patella	12,061	74 (68 to 79)	43	0.33 (0.24-0.45)	1.28 (1.08-1.51)	1.65 (1.42-1.91)	2.05 (1.76-2.40)		
Persona CR[Fem]Persona[Tib]									
Cemented, unconstrained, fixed, with patella	3,060	69 (62 to 75)	40	0.41 (0.22-0.76)	0.66 (0.36-1.21)	*0.66 (0.36-1.21)*			

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[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Cemented, unconstrained, fixed, without patella	3,843	70 (63 to 76)	49	0.27 (0.14-0.53)	0.90 (0.58-1.41)	1.72 (1.02-2.89)			
Scorpio NRG[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	3,789	70 (64 to 76)	38	0.42 (0.26-0.69)	1.23 (0.92-1.64)	2.00 (1.59-2.51)	3.31 (2.71-4.03)		
Cemented, unconstrained, fixed, without patella	4,805	70 (64 to 76)	46	0.31 (0.19-0.52)	1.61 (1.29-2.01)	2.64 (2.22-3.15)	3.65 (3.12-4.27)		
Cemented, posterior-stabilised, fixed, with patella	3,109	71 (64 to 77)	42	0.49 (0.29-0.80)	1.31 (0.96-1.78)	1.89 (1.46-2.45)	2.92 (2.35-3.64)	*3.28 (2.54-4.24)*	
Cemented, posterior-stabilised, fixed, without patella	1,626	69 (63 to 76)	47	0.37 (0.17-0.82)	2.45 (1.80-3.34)	3.36 (2.58-4.38)	5.50 (4.43-6.80)		
Scorpio[Fem]Scorpio NRG[Tib]									
Cemented, unconstrained, fixed, with patella	3,070	72 (65 to 77)	38	0.36 (0.20-0.65)	1.23 (0.89-1.69)	1.89 (1.46-2.45)	3.35 (2.74-4.10)	4.24 (3.49-5.13)	*4.40 (3.60-5.36)*
Cemented, unconstrained, fixed, without patella	7,445	70 (64 to 77)	43	0.47 (0.34-0.66)	2.09 (1.78-2.44)	2.85 (2.49-3.26)	4.08 (3.63-4.57)	5.43 (4.85-6.08)	*5.63 (5.01-6.32)*
Cemented, posterior-stabilised, fixed, with patella	3,488	71 (65 to 77)	38	0.14 (0.06-0.35)	1.15 (0.84-1.57)	1.80 (1.40-2.31)	3.03 (2.49-3.70)	4.31 (3.61-5.15)	*4.31 (3.61-5.15)*
Cemented, posterior-stabilised, fixed, without patella	2,597	72 (65 to 77)	42	0.31 (0.16-0.62)	2.35 (1.82-3.02)	3.60 (2.93-4.41)	5.65 (4.79-6.67)	6.91 (5.91-8.08)	*8.00 (6.60-9.68)*
Uncemented, unconstrained, fixed, with patella	815	71 (63 to 77)	39	0.37 (0.12-1.15)	1.75 (1.04-2.93)	2.52 (1.63-3.88)	3.23 (2.19-4.75)	*3.84 (2.65-5.56)*	
Uncemented, unconstrained, fixed, without patella	2,940	70 (64 to 76)	49	0.68 (0.44-1.06)	1.97 (1.52-2.54)	2.61 (2.09-3.27)	4.10 (3.42-4.92)	4.91 (4.12-5.85)	*6.50 (4.30-9.77)*
TC Plus[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	557	71 (64 to 76)	38	0.18 (0.03-1.27)	1.45 (0.73-2.88)	2.57 (1.53-4.31)	3.90 (2.53-5.99)	*5.13 (3.42-7.66)*	*5.13 (3.42-7.66)*
Cemented, unconstrained, fixed, without patella	7,385	70 (64 to 76)	47	0.86 (0.67-1.10)	2.04 (1.74-2.40)	2.63 (2.29-3.03)	3.72 (3.30-4.20)	4.88 (4.32-5.51)	*5.48 (4.70-6.39)*
Cemented, unconstrained, mobile, with patella	238	72 (65 to 77)	36	*0.00 (.-)*	*0.45 (0.06-3.14)*	*1.39 (0.45-4.26)*	*1.39 (0.45-4.26)*	*1.39 (0.45-4.26)*	
Cemented, unconstrained, mobile, without patella	5,223	70 (64 to 76)	44	0.54 (0.37-0.78)	1.53 (1.23-1.91)	2.02 (1.67-2.45)	3.15 (2.69-3.69)	3.99 (3.42-4.66)	

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[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Triathlon[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	52,105	70 (63 to 76)	39	0.42 (0.36-0.48)	1.13 (1.03-1.23)	1.54 (1.42-1.67)	2.36 (2.16-2.58)	*3.20 (2.57-3.99)*	
Cemented, unconstrained, fixed, without patella	75,688	70 (63 to 76)	47	0.46 (0.42-0.52)	1.48 (1.39-1.58)	2.07 (1.96-2.20)	3.02 (2.83-3.21)	*3.76 (3.30-4.27)*	
Cemented, posterior-stabilised, fixed, with patella	17,858	70 (63 to 76)	40	0.58 (0.48-0.71)	1.47 (1.30-1.68)	2.18 (1.95-2.44)	3.05 (2.72-3.43)		
Cemented, posterior-stabilised, fixed, without patella	8,905	70 (63 to 77)	44	0.69 (0.53-0.89)	2.19 (1.89-2.54)	3.00 (2.63-3.43)	4.29 (3.72-4.95)		
Uncemented, unconstrained, fixed, with patella	1,628	68 (60 to 75)	47	0.81 (0.45-1.46)	1.38 (0.83-2.28)	*1.38 (0.83-2.28)*	*1.38 (0.83-2.28)*		
Uncemented, unconstrained, fixed, without patella	3,410	69 (61 to 75)	53	0.50 (0.31-0.82)	1.94 (1.49-2.52)	2.39 (1.85-3.09)	3.05 (2.26-4.11)		
Vanguard[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	29,783	70 (64 to 76)	38	0.33 (0.27-0.40)	0.94 (0.83-1.07)	1.40 (1.26-1.56)	2.44 (2.09-2.84)		
Cemented, unconstrained, fixed, without patella	42,204	70 (64 to 76)	45	0.38 (0.33-0.45)	1.55 (1.43-1.68)	2.21 (2.06-2.37)	3.05 (2.83-3.29)		
Cemented, posterior-stabilised, fixed, with patella	6,181	70 (63 to 76)	38	0.57 (0.41-0.80)	1.67 (1.36-2.05)	2.44 (2.04-2.92)	3.34 (2.76-4.04)		
Cemented, posterior-stabilised, fixed, without patella	4,812	70 (63 to 77)	44	0.69 (0.49-0.97)	2.59 (2.15-3.11)	3.34 (2.83-3.95)	5.10 (4.16-6.24)		
Cemented, constrained condylar, with patella	2,161	70 (63 to 76)	32	0.51 (0.28-0.95)	1.07 (0.68-1.68)	1.52 (1.01-2.29)	*1.70 (1.12-2.60)*		
Cemented, constrained condylar, without patella	1,965	70 (63 to 77)	40	0.44 (0.22-0.88)	1.44 (0.95-2.19)	1.56 (1.03-2.35)	*1.92 (1.24-2.95)*		
Unicondylar knee replacements									
AMC/Uniglide[Fem:Tib]									
Cemented, monobloc polyethylene tibia	1,087	67 (59 to 75)	50	0.28 (0.09-0.86)	2.99 (2.12-4.20)	4.61 (3.49-6.07)	8.08 (6.44-10.10)	*11.67 (9.25-14.68)*	
Journey Uni Oxinium[Fem]Journey Uni[Tib]									
Cemented, fixed	1,500	63 (56 to 70)	53	1.50 (0.98-2.29)	3.01 (2.19-4.13)	4.38 (3.24-5.89)			
MG Uni[Fem:Tib]									
Cemented, fixed	1,501	62 (56 to 69)	55	1.00 (0.60-1.65)	4.37 (3.44-5.54)	6.57 (5.42-7.96)	11.37 (9.82-13.14)	14.35 (12.54-16.41)	*15.40 (13.30-17.80)*

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[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	18 years
Oxford Cementless Partial Knee[Fem:Tib]									
Uncemented/Hybrid, mobile	28,873	65 (58 to 72)	56	1.16 (1.04-1.29)	2.28 (2.10-2.48)	3.24 (2.99-3.49)	5.95 (5.32-6.65)		
Oxford Cementless Partial Knee[Fem]Oxford Partial Knee[Tib]									
Uncemented/Hybrid, mobile	1,571	65 (58 to 73)	50	1.43 (0.94-2.17)	4.17 (3.26-5.33)	5.82 (4.70-7.19)	9.47 (7.80-11.47)	*12.87 (10.16-16.24)*	
Oxford Single Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	43,376	64 (58 to 71)	52	1.21 (1.11-1.32)	4.35 (4.16-4.55)	6.46 (6.23-6.70)	11.53 (11.20-11.86)	16.89 (16.39-17.40)	19.91 (18.93-20.94)
Oxford Twin Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	5,660	65 (57 to 72)	49	0.77 (0.57-1.04)	2.45 (2.05-2.92)	3.77 (3.24-4.37)	7.29 (6.29-8.44)	*11.50 (9.03-14.60)*	
Persona Partial Knee[Fem:Tib]									
Cemented, fixed	3,826	65 (58 to 72)	58	0.19 (0.09-0.43)	1.41 (0.92-2.15)				
***Physica ZUK[Fem:Tib]**									
Cemented, fixed	19,566	63 (56 to 71)	55	0.37 (0.29-0.47)	1.64 (1.45-1.85)	2.58 (2.32-2.86)	5.51 (4.93-6.16)	*7.78 (6.36-9.51)*	
Cemented, monobloc polyethylene tibia	2,171	64 (56 to 71)	56	0.20 (0.07-0.53)	2.86 (2.20-3.71)	4.14 (3.30-5.18)	7.73 (6.26-9.53)		
Restoris[Fem:Tib]									
Cemented, fixed	1,410	65 (58 to 73)	59	0.37 (0.14-0.99)	1.70 (0.97-2.95)	*1.70 (0.97-2.95)*			
Sigma HP (Uni)[Fem]Sigma HP[Tib]									
Cemented, fixed	13,836	63 (56 to 70)	58	0.71 (0.58-0.87)	2.68 (2.41-2.99)	3.74 (3.40-4.12)	6.41 (5.77-7.11)		
Triathlon Uni[Fem]Triathlon[Tib]									
Cemented, fixed	1,651	62 (56 to 70)	55	1.15 (0.73-1.82)	3.87 (3.00-4.99)	6.22 (5.00-7.73)	*7.89 (6.35-9.78)*		
Patellofemoral knee replacements									
Avon[Fem]									
Patellofemoral	6,685	58 (50 to 67)	22	0.66 (0.49-0.89)	4.09 (3.63-4.61)	7.24 (6.60-7.94)	14.55 (13.55-15.63)	21.35 (19.82-22.99)	*24.67 (22.05-27.54)*
FPV[Fem]									
Patellofemoral	1,651	59 (52 to 68)	23	0.85 (0.50-1.43)	6.94 (5.81-8.29)	10.17 (8.79-11.75)	18.42 (16.49-20.56)		
Journey PFJ Oxinium[Fem]									
Patellofemoral	2,290	58 (50 to 67)	23	1.85 (1.36-2.50)	7.25 (6.22-8.44)	12.29 (10.90-13.85)	20.98 (18.98-23.15)	*25.54 (22.64-28.73)*	
Sigma HP (PF)[Fem]									
Patellofemoral	1,304	58 (50 to 66)	23	2.69 (1.94-3.73)	9.42 (7.95-11.14)	13.67 (11.90-15.68)	24.31 (21.56-27.34)		
Zimmer PFJ[Fem]									
Patellofemoral	3,571	56 (49 to 65)	22	0.60 (0.39-0.93)	4.04 (3.39-4.81)	6.87 (5.95-7.93)	13.18 (11.41-15.20)		

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

3.3.4 Revisions for different indications after primary knee replacement

Table 3.K10 (page 185) shows the revision incidence rates for each indication recorded on data collection forms for knee revision surgery, for all cases and then sub-divided by fixation type and whether the primary procedure was a TKR or a UKR.

For all knee replacements, the highest Prosthesis Time Incidence Rates (PTIRs) for the five most common indications for revision in descending order, were for: aseptic loosening / lysis, infection, progressive arthritis, pain and instability. For cemented TKR, the highest PTIRs in descending order were aseptic loosening / lysis, infection, instability, pain and 'other' indication. Revision incidences for TKRs which were uncemented were lower than cemented TKR for infection, the same for periprosthetic fracture but higher for all other recorded indications.

For cemented unicondylar knee replacements (medial and lateral UKR), the highest three incidence rates for indications for revising the implant were for: progressive arthritis, aseptic loosening / lysis and pain, respectively. For uncemented / hybrid unicondylar knee replacements (medial and lateral UKR) the highest rates were for: progressive arthritis, aseptic loosening / lysis and dislocation / subluxation. The incidence of revision for pain, aseptic loosening / lysis, implant wear and progressive arthritis were lower for uncemented / hybrid fixation than for cemented but the incidence was higher for dislocation / subluxation and periprosthetic fracture. For patellofemoral replacements, the top three indications for revision were: progressive arthritis, pain and 'other' indication. Similarly, for multicompartmental knee replacements, the highest incidence for revision was for progressive arthritis, pain and 'other' indication.

In Table 3.K11 (page 188), the PTIRs for each indication are shown separately for different time periods from the primary knee replacement, within the first year from primary operation, and between 1 to <3, 3 to <5, 5 to <7, 7 to <10, 10 to <13, 13 to <15, 15 to <17 and ≥17 years after surgery (the maximum follow-up for any implant is now 18.75 years). It is clear that most of the PTIRs for a particular indication do vary, especially for infection, aseptic loosening / lysis, pain and progressive arthritis for different time intervals after surgery. Infection is most likely to be the reason that a joint is revised in the first year but after seven years or more, is comparatively less likely than some of the other reasons. Conversely, revision between one and three years after surgery is more likely for aseptic loosening / lysis and pain, with incidence rates dropping off for pain later on but rising again for aseptic loosening / lysis. Aseptic loosening / lysis PTIRs continue to remain relatively higher than other indicated reasons for revision for implants surviving for longer periods after surgery.

Table 3.K10 PTIR estimates of indications for revision (95% CI) by fixation, constraint, bearing type and whether a patella component was recorded.

Fixation, constraint and bearing sub-groups	Pros-thesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for:										Stiffness[3]		Progressive arthritis[4]	
		All causes	Pain	Dislocation/ Subluxation	Infection	Aseptic loosening /Lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalign-ment	Other indication[2]	Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe-sis-years	Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
All cases	10,058.8	4.36 (4.32-4.40)	0.62 (0.61-0.64)	0.16 (0.15-0.16)	0.84 (0.82-0.86)	1.16 (1.14-1.19)	0.17 (0.17-0.18)	0.29 (0.28-0.30)	0.61 (0.60-0.63)	0.30 (0.29-0.31)	0.46 (0.45-0.48)	9,785.9	0.27 (0.26-0.28)	7,499.5	0.72 (0.70-0.74)
Total knee replacement															
All cemented	8,300.8	3.48 (3.44-3.52)	0.44 (0.43-0.46)	0.09 (0.09-0.10)	0.91 (0.88-0.93)	0.96 (0.94-0.98)	0.17 (0.16-0.17)	0.18 (0.17-0.19)	0.58 (0.56-0.59)	0.27 (0.26-0.28)	0.33 (0.31-0.34)	8,091.1	0.28 (0.26-0.29)	6,294.4	0.33 (0.32-0.35)
unconstrained, fixed, with patella	1,955.2	2.76 (2.69-2.84)	0.28 (0.26-0.31)	0.07 (0.06-0.09)	0.87 (0.83-0.91)	0.80 (0.76-0.84)	0.13 (0.11-0.15)	0.18 (0.16-0.20)	0.55 (0.52-0.59)	0.24 (0.22-0.26)	0.21 (0.19-0.23)	1,900.7	0.24 (0.22-0.26)	1,509.1	0.02 (0.02-0.03)
unconstrained, fixed, without patella	3,660.4	3.39 (3.34-3.45)	0.51 (0.49-0.54)	0.09 (0.08-0.10)	0.81 (0.78-0.84)	0.78 (0.75-0.81)	0.13 (0.12-0.15)	0.17 (0.15-0.18)	0.54 (0.52-0.56)	0.26 (0.25-0.28)	0.36 (0.34-0.38)	3,575.7	0.28 (0.27-0.30)	2,806.7	0.52 (0.49-0.54)
unconstrained, mobile, with patella	90.6	4.83 (4.39-5.30)	0.47 (0.35-0.64)	0.32 (0.22-0.46)	1.19 (0.99-1.44)	1.60 (1.36-1.88)	0.14 (0.08-0.25)	0.45 (0.33-0.61)	1.05 (0.86-1.28)	0.38 (0.27-0.53)	0.31 (0.21-0.45)	86.9	0.55 (0.42-0.73)	55.9	0.00 (.-.)
unconstrained, mobile, without patella	278.6	3.79 (3.57-4.03)	0.66 (0.57-0.76)	0.15 (0.11-0.20)	0.74 (0.64-0.85)	1.29 (1.17-1.43)	0.17 (0.13-0.22)	0.28 (0.22-0.35)	0.66 (0.57-0.77)	0.35 (0.29-0.42)	0.33 (0.27-0.41)	272.0	0.35 (0.29-0.43)	166.8	0.29 (0.22-0.39)
posterior-stabilised, fixed, with patella	1,018.2	3.49 (3.38-3.61)	0.29 (0.26-0.33)	0.08 (0.07-0.10)	1.14 (1.08-1.21)	1.18 (1.12-1.25)	0.24 (0.21-0.27)	0.17 (0.15-0.20)	0.55 (0.51-0.60)	0.26 (0.23-0.30)	0.23 (0.20-0.26)	991.2	0.24 (0.21-0.27)	777.2	0.03 (0.02-0.04)
posterior-stabilised, fixed, without patella	990.0	4.77 (4.63-4.91)	0.58 (0.54-0.63)	0.09 (0.08-0.11)	1.02 (0.96-1.09)	1.57 (1.49-1.65)	0.24 (0.22-0.28)	0.20 (0.18-0.23)	0.69 (0.64-0.75)	0.31 (0.27-0.34)	0.46 (0.42-0.50)	961.0	0.29 (0.26-0.33)	734.4	0.63 (0.58-0.69)
posterior-stabilised, mobile, with patella	79.1	3.37 (2.99-3.80)	0.39 (0.28-0.56)	0.08 (0.03-0.17)	0.90 (0.71-1.13)	0.96 (0.77-1.20)	0.18 (0.10-0.30)	0.19 (0.11-0.31)	0.70 (0.53-0.91)	0.21 (0.13-0.35)	0.35 (0.24-0.51)	77.7	0.44 (0.31-0.61)	55.6	0.02 (0.00-0.13)
posterior-stabilised, mobile, without patella	40.7	5.89 (5.19-6.69)	0.98 (0.72-1.34)	0.22 (0.11-0.42)	0.76 (0.54-1.08)	1.18 (0.89-1.56)	0.32 (0.19-0.55)	0.42 (0.26-0.67)	0.96 (0.70-1.31)	0.17 (0.08-0.36)	1.18 (0.89-1.56)	39.5	0.56 (0.37-0.84)	22.9	1.09 (0.74-1.62)
constrained condylar, with patella	25.1	4.39 (3.64-5.29)	0.20 (0.08-0.48)	0.28 (0.13-0.59)	2.07 (1.58-2.72)	0.68 (0.42-1.09)	0.36 (0.19-0.69)	0.08 (0.02-0.32)	0.68 (0.42-1.09)	0.04 (0.01-0.28)	0.52 (0.30-0.89)	24.8	0.28 (0.13-0.59)	22.4	0.09 (0.02-0.36)
constrained condylar, without patella	31.6	5.86 (5.07-6.77)	0.41 (0.24-0.71)	0.25 (0.13-0.51)	2.63 (2.12-3.26)	0.89 (0.61-1.28)	0.51 (0.31-0.83)	0.35 (0.19-0.63)	0.66 (0.43-1.02)	0.35 (0.19-0.63)	0.44 (0.26-0.75)	31.2	0.35 (0.20-0.64)	27.4	0.62 (0.39-1.00)
monobloc polyethylene tibia, with patella	26.1	2.18 (1.68-2.83)	0.23 (0.10-0.51)	0.04 (0.01-0.27)	0.65 (0.40-1.05)	0.57 (0.35-0.95)	0.19 (0.08-0.46)	0.08 (0.02-0.31)	0.57 (0.35-0.95)	0.31 (0.15-0.61)	0.15 (0.06-0.41)	26.1	0.23 (0.10-0.51)	24.1	0.00 (.-.)
monobloc polyethylene tibia, without patella	93.3	2.85 (2.53-3.21)	0.44 (0.32-0.60)	0.10 (0.05-0.19)	0.71 (0.56-0.90)	0.70 (0.55-0.89)	0.20 (0.13-0.32)	0.05 (0.02-0.13)	0.42 (0.31-0.57)	0.24 (0.16-0.36)	0.30 (0.21-0.43)	92.7	0.22 (0.14-0.33)	82.7	0.19 (0.12-0.32)

[1]The indication implant failure, as reported in annual reports up to 2013, has been renamed implant wear as this reflects the wearing down of the implant but distinguishes from the implant itself breaking.
[2]Other indication now includes other indications not listed, implant fracture and incorrect sizing.
[3]Stiffness was asked in versions MDSv2, v3, v6 and v7 of the data collection forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.
[4]Progressive arthritis was asked in versions MDSv3, v6 and v7 of the data collection forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.

Table 3.K10 (continued)

Fixation, constraint and bearing sub-groups	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for:										Stiffness[3]		Progressive arthritis[4]	
		All causes	Pain	Dislocation/ Subluxation	Infection	Aseptic loosening /Lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalign-ment	Other indication[2]	Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe-sis-years	Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
pre-assembled/ hinged/linked, with patella	2.2	13.82 (9.72-19.66)	0.45 (0.06-3.17)	1.34 (0.43-4.15)	7.58 (4.71-12.19)	1.34 (0.43-4.15)	0.89 (0.22-3.57)	0.45 (0.06-3.17)	0.45 (0.06-3.17)	0.89 (0.22-3.57)	1.78 (0.67-4.75)	2.2	0.45 (0.06-3.19)	1.6	1.23 (0.31-4.92)
pre-assembled/ hinged/linked, without patella	9.5	9.96 (8.15-12.18)	0.31 (0.10-0.98)	0.84 (0.42-1.68)	3.57 (2.55-4.99)	2.10 (1.35-3.25)	0.94 (0.49-1.81)	0.73 (0.35-1.54)	0.52 (0.22-1.26)	0.84 (0.42-1.68)	1.15 (0.64-2.08)	9.3	0.32 (0.10-1.00)	7.5	0.67 (0.28-1.60)
All uncemented	**424.0**	**4.18 (3.99-4.38)**	**0.77 (0.69-0.86)**	**0.15 (0.12-0.19)**	**0.57 (0.51-0.65)**	**1.44 (1.33-1.56)**	**0.17 (0.13-0.21)**	**0.33 (0.28-0.39)**	**0.71 (0.63-0.79)**	**0.36 (0.31-0.42)**	**0.54 (0.47-0.61)**	**405.1**	**0.34 (0.28-0.40)**	**257.8**	**0.41 (0.34-0.50)**
unconstrained, fixed, with patella	21.1	4.12 (3.34-5.09)	0.28 (0.13-0.63)	0.19 (0.07-0.51)	0.76 (0.46-1.24)	1.61 (1.15-2.26)	0.28 (0.13-0.63)	0.19 (0.07-0.51)	1.09 (0.72-1.64)	0.62 (0.36-1.06)	0.14 (0.05-0.44)	20.8	0.19 (0.07-0.51)	16.3	0.06 (0.01-0.44)
unconstrained, fixed, without patella	141.4	4.34 (4.01-4.70)	0.78 (0.65-0.94)	0.07 (0.04-0.13)	0.57 (0.45-0.70)	1.63 (1.43-1.85)	0.18 (0.12-0.26)	0.33 (0.25-0.44)	0.65 (0.53-0.80)	0.35 (0.26-0.46)	0.59 (0.47-0.73)	134.1	0.33 (0.24-0.44)	84.2	0.53 (0.40-0.72)
unconstrained, mobile, with patella	9.9	5.45 (4.18-7.12)	0.81 (0.40-1.62)	0.20 (0.05-0.81)	0.81 (0.40-1.62)	2.02 (1.30-3.13)	0.20 (0.05-0.81)	1.21 (0.69-2.13)	1.62 (0.99-2.64)	0.91 (0.47-1.75)	0.71 (0.34-1.48)	9.0	0.56 (0.23-1.34)	4.7	0.00 (.-.)
unconstrained, mobile, without patella	219.6	3.81 (3.56-4.07)	0.75 (0.64-0.87)	0.17 (0.12-0.23)	0.52 (0.44-0.63)	1.24 (1.10-1.39)	0.12 (0.08-0.17)	0.27 (0.21-0.35)	0.62 (0.53-0.74)	0.28 (0.22-0.36)	0.48 (0.40-0.58)	210.7	0.31 (0.25-0.40)	132.8	0.43 (0.33-0.56)
posterior-stabilised, fixed, with patella	6.0	7.85 (5.89-10.44)	1.17 (0.56-2.45)	0.67 (0.25-1.78)	1.34 (0.67-2.67)	2.84 (1.76-4.56)	1.00 (0.45-2.23)	0.67 (0.25-1.78)	1.50 (0.78-2.89)	0.67 (0.25-1.78)	0.67 (0.25-1.78)	5.6	0.90 (0.37-2.16)	3.4	0.00 (.-.)
posterior-stabilised, fixed, without patella	23.7	5.40 (4.54-6.42)	1.14 (0.78-1.66)	0.25 (0.11-0.56)	0.55 (0.32-0.94)	1.60 (1.17-2.20)	0.21 (0.09-0.51)	0.59 (0.35-1.00)	0.97 (0.64-1.46)	0.63 (0.38-1.05)	1.05 (0.71-1.56)	22.6	0.44 (0.24-0.82)	14.4	0.28 (0.10-0.74)
other constraints, with patella	0.2	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.00 (.-.)	0.2	0.00 (.-.)	0.2	0.00 (.-.)
other constraints, without patella	2.1	3.81 (1.90-7.61)	2.38 (0.99-5.72)	0.48 (0.07-3.38)	1.43 (0.46-4.43)	0.48 (0.07-3.38)	0.00 (.-.)	0.00 (.-.)	0.48 (0.07-3.38)	0.00 (.-.)	0.48 (0.07-3.38)	2.1	0.96 (0.24-3.85)	1.9	0.00 (.-.)
All hybrid	**96.3**	**3.46 (3.10-3.85)**	**0.55 (0.42-0.72)**	**0.13 (0.08-0.23)**	**0.82 (0.66-1.02)**	**1.09 (0.90-1.32)**	**0.16 (0.09-0.26)**	**0.32 (0.23-0.46)**	**0.58 (0.45-0.76)**	**0.29 (0.20-0.42)**	**0.26 (0.18-0.38)**	**88.3**	**0.19 (0.12-0.31)**	**47.2**	**0.30 (0.18-0.50)**
unconstrained, fixed, with patella	24.7	2.47 (1.92-3.18)	0.41 (0.22-0.75)	0.12 (0.04-0.38)	0.65 (0.40-1.06)	0.81 (0.52-1.26)	0.16 (0.06-0.43)	0.36 (0.19-0.70)	0.61 (0.37-1.01)	0.04 (0.01-0.29)	0.12 (0.04-0.38)	22.4	0.09 (0.02-0.36)	8.5	0.00 (.-.)
unconstrained, fixed, without patella	44.7	3.36 (2.86-3.94)	0.56 (0.38-0.83)	0.11 (0.05-0.27)	0.81 (0.58-1.12)	0.98 (0.73-1.32)	0.16 (0.07-0.33)	0.29 (0.17-0.50)	0.38 (0.24-0.61)	0.36 (0.22-0.58)	0.31 (0.19-0.53)	40.1	0.17 (0.08-0.37)	21.7	0.32 (0.15-0.68)
unconstrained, mobile, with patella	2.6	5.37 (3.18-9.07)	0.00 (.-.)	0.38 (0.05-2.72)	0.77 (0.19-3.07)	2.69 (1.28-5.63)	0.38 (0.05-2.72)	0.38 (0.05-2.72)	0.38 (0.05-2.72)	0.38 (0.05-2.72)	0.38 (0.05-2.72)	2.4	0.82 (0.21-3.30)	2.1	0.00 (.-.)

[1]The indication implant failure, as reported in annual reports up to 2013, has been renamed implant wear as this reflects the wearing down of the implant but distinguishes from the implant itself breaking.
[2]Other indication now includes other indications not listed, implant fracture and incorrect sizing.
[3]Stiffness was asked in versions MDSv2, v3, v6 and v7 of the data collection forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.
[4]Progressive arthritis was asked in versions MDSv3, v6 and v7 of the data collection forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.

Table 3.K10 (continued)

Fixation, constraint and bearing sub-groups	Pros-thesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Pain	Dislocation/ Subluxation	Infection	Aseptic loosening /Lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalign-ment	Other indication[2]	Stiffness[3] Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe-sis-years	Progressive arthritis[4] Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
unconstrained, mobile, without patella	14.0	4.08 (3.15-5.30)	0.57 (0.29-1.15)	0.21 (0.07-0.67)	0.86 (0.49-1.51)	1.50 (0.98-2.31)	0.00 (.-.)	0.50 (0.24-1.05)	0.93 (0.54-1.60)	0.64 (0.34-1.24)	0.43 (0.19-0.96)	13.3	0.23 (0.07-0.70)	10.0	0.40 (0.15-1.07)
posterior-stabilised, fixed, with patella	2.5	5.70 (3.37-9.62)	1.63 (0.61-4.34)	0.00 (.-.)	1.63 (0.61-4.34)	2.44 (1.10-5.44)	0.81 (0.20-3.25)	0.00 (.-.)	0.41 (0.06-2.89)	0.00 (.-.)	0.00 (.-.)	2.3	0.43 (0.06-3.03)	1.5	0.00 (.-.)
posterior-stabilised, fixed, without patella	3.6	4.71 (2.93-7.58)	0.28 (0.04-1.97)	0.00 (.-.)	1.66 (0.75-3.70)	1.39 (0.58-3.33)	0.00 (.-.)	0.00 (.-.)	1.11 (0.42-2.95)	0.00 (.-.)	0.00 (.-.)	3.4	0.00 (.-.)	1.9	0.52 (0.07-3.69)
other constraints, with patella	2.7	4.12 (2.28-7.44)	1.50 (0.56-3.99)	0.00 (.-.)	0.75 (0.19-3.00)	0.37 (0.05-2.66)	0.37 (0.05-2.66)	0.37 (0.05-2.66)	0.75 (0.19-3.00)	0.00 (.-.)	0.37 (0.05-2.66)	2.7	0.37 (0.05-2.66)	0.4	0.00 (.-.)
other constraints, without patella	1.7	5.27 (2.74-10.14)	0.59 (0.08-4.16)	0.59 (0.08-4.16)	0.59 (0.08-4.16)	0.59 (0.08-4.16)	0.00 (.-.)	0.00 (.-.)	1.76 (0.57-5.45)	0.59 (0.08-4.16)	0.00 (.-.)	1.7	0.61 (0.09-4.30)	1.0	2.03 (0.51-8.11)
Unicompartmental knee replacement															
All unicondylar, cemented	**757.0**	**10.88 (10.64-11.11)**	**1.95 (1.85-2.05)**	**0.57 (0.52-0.63)**	**0.43 (0.39-0.48)**	**2.99 (2.87-3.12)**	**0.20 (0.17-0.23)**	**1.09 (1.02-1.17)**	**0.87 (0.81-0.94)**	**0.52 (0.47-0.57)**	**1.39 (1.31-1.48)**	**734.2**	**0.16 (0.14-0.20)**	**537.4**	**3.47 (3.31-3.63)**
fixed	234.2	7.66 (7.31-8.02)	1.37 (1.23-1.53)	0.08 (0.05-0.12)	0.48 (0.40-0.58)	2.09 (1.91-2.28)	0.18 (0.14-0.25)	0.68 (0.59-0.80)	0.55 (0.46-0.65)	0.35 (0.28-0.43)	0.83 (0.72-0.95)	231.6	0.15 (0.10-0.21)	208.2	2.70 (2.49-2.94)
mobile	465.7	12.42 (12.10-12.74)	2.15 (2.02-2.28)	0.88 (0.80-0.97)	0.41 (0.35-0.47)	3.34 (3.17-3.51)	0.18 (0.15-0.22)	1.29 (1.19-1.40)	1.04 (0.95-1.14)	0.59 (0.53-0.67)	1.73 (1.61-1.85)	447.0	0.17 (0.13-0.21)	295.8	3.97 (3.75-4.21)
monobloc polyethylene tibia	57.1	11.47 (10.62-12.38)	2.66 (2.27-3.12)	0.14 (0.07-0.28)	0.46 (0.31-0.67)	3.87 (3.39-4.41)	0.37 (0.24-0.56)	1.16 (0.91-1.47)	0.82 (0.62-1.10)	0.58 (0.41-0.81)	0.95 (0.72-1.23)	55.6	0.22 (0.12-0.38)	33.4	3.74 (3.14-4.46)
All unicondylar, uncemented/hybrid	**150.4**	**8.05 (7.61-8.52)**	**0.81 (0.68-0.97)**	**1.20 (1.03-1.38)**	**0.46 (0.36-0.58)**	**1.23 (1.06-1.42)**	**0.57 (0.46-0.70)**	**0.84 (0.71-1.00)**	**0.73 (0.61-0.88)**	**0.38 (0.29-0.49)**	**1.08 (0.93-1.26)**	**150.2**	**0.10 (0.06-0.17)**	**145.0**	**2.30 (2.07-2.56)**
fixed	7.8	9.97 (7.99-12.45)	1.41 (0.78-2.54)	0.13 (0.02-0.91)	0.00 (.-.)	4.09 (2.89-5.79)	0.13 (0.02-0.91)	1.41 (0.78-2.54)	1.02 (0.51-2.05)	0.51 (0.19-1.36)	1.66 (0.97-2.86)	7.7	0.26 (0.07-1.04)	6.5	2.62 (1.63-4.21)
mobile	138.0	7.91 (7.46-8.40)	0.72 (0.59-0.87)	1.30 (1.12-1.50)	0.50 (0.39-0.63)	1.03 (0.87-1.21)	0.61 (0.49-0.75)	0.80 (0.66-0.96)	0.72 (0.59-0.87)	0.38 (0.29-0.50)	1.07 (0.91-1.26)	137.9	0.08 (0.04-0.14)	134.6	2.26 (2.02-2.53)
monobloc polyethylene tibia	4.6	8.90 (6.55-12.08)	2.60 (1.48-4.59)	0.00 (.-.)	0.00 (.-.)	2.39 (1.32-4.31)	0.00 (.-.)	1.30 (0.59-2.90)	0.65 (0.21-2.02)	0.00 (.-.)	0.43 (0.11-1.74)	4.6	0.43 (0.11-1.74)	4.0	3.29 (1.91-5.66)
Patellofemoral	**119.4**	**18.95 (18.19-19.75)**	**3.92 (3.58-4.29)**	**0.59 (0.47-0.75)**	**0.39 (0.29-0.51)**	**2.24 (1.99-2.53)**	**0.14 (0.09-0.23)**	**1.61 (1.40-1.85)**	**0.88 (0.73-1.06)**	**1.09 (0.92-1.29)**	**2.83 (2.54-3.15)**	**116.7**	**0.39 (0.30-0.53)**	**90.2**	**9.49 (8.88-10.15)**
Multi Unicompartmental	**4.7**	**15.17 (12.04-19.11)**	**3.16 (1.90-5.24)**	**0.63 (0.20-1.96)**	**0.42 (0.11-1.68)**	**1.26 (0.57-2.81)**	**0.21 (0.03-1.50)**	**1.26 (0.57-2.81)**	**0.84 (0.32-2.25)**	**0.84 (0.32-2.25)**	**2.95 (1.75-4.98)**	**4.7**	**0.00 (.-.)**	**4.4**	**6.60 (4.59-9.49)**
Unconfirmed															
	206.2	5.36 (5.05-5.68)	0.71 (0.60-0.83)	0.20 (0.15-0.27)	0.82 (0.71-0.96)	1.57 (1.41-1.75)	0.19 (0.14-0.26)	0.47 (0.38-0.57)	0.81 (0.70-0.95)	0.34 (0.27-0.43)	0.70 (0.59-0.82)	195.8	0.29 (0.22-0.37)	123.1	1.04 (0.87-1.24)

[1]The indication implant failure, as reported in annual reports up to 2013, has been renamed implant wear as this reflects the wearing down of the implant but distinguishes from the implant itself breaking.
[2]Other indication now includes other indications not listed, implant fracture and incorrect sizing.
[3]Stiffness was asked in versions MDSv2, v3, v6 and v7 of the data collection forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.
[4]Progressive arthritis was asked in versions MDSv3, v6 and v7 of the data collection forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.

Table 3.K11 PTIR estimates of indications for revision (95% CI) by years following primary knee replacement.

Time since primary (years)	Pros-thesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for:										Stiffness[3]		Progressive arthritis[4]	
		All causes	Pain	Dislocation/ Subluxation	Infection	Aseptic loosening /Lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalign-ment	Other indication[2]	Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe sis-years	Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe sis-years
All cases	10,058.8	4.36 (4.32-4.40)	0.62 (0.61-0.64)	0.16 (0.15-0.16)	0.84 (0.82-0.86)	1.16 (1.14-1.19)	0.17 (0.17-0.18)	0.29 (0.28-0.30)	0.61 (0.60-0.63)	0.30 (0.29-0.31)	0.46 (0.45-0.48)	9,785.9	0.27 (0.26-0.28)	7,499.5	0.72 (0.70-0.74)
<1	1,389.2	4.94 (4.83-5.06)	0.46 (0.43-0.50)	0.37 (0.34-0.41)	1.98 (1.91-2.06)	0.60 (0.56-0.64)	0.31 (0.28-0.34)	0.18 (0.16-0.20)	0.52 (0.48-0.56)	0.30 (0.28-0.33)	0.56 (0.53-0.61)	1,368.1	0.29 (0.26-0.32)	1,177.0	0.26 (0.23-0.29)
1 to <3	2,510.9	6.16 (6.06-6.26)	1.22 (1.18-1.27)	0.18 (0.17-0.20)	1.17 (1.12-1.21)	1.44 (1.40-1.49)	0.12 (0.11-0.14)	0.19 (0.17-0.21)	0.92 (0.88-0.96)	0.52 (0.49-0.55)	0.73 (0.69-0.76)	2,470.2	0.52 (0.49-0.55)	2,100.1	0.89 (0.85-0.93)
3 to <5	2,022.7	3.96 (3.87-4.04)	0.68 (0.65-0.72)	0.09 (0.08-0.11)	0.60 (0.56-0.63)	1.22 (1.17-1.27)	0.12 (0.11-0.14)	0.19 (0.17-0.21)	0.59 (0.56-0.63)	0.31 (0.28-0.33)	0.42 (0.39-0.44)	1,984.3	0.25 (0.23-0.28)	1,633.8	0.73 (0.69-0.77)
5 to <7	1,532.8	3.25 (3.16-3.34)	0.40 (0.37-0.43)	0.09 (0.07-0.10)	0.47 (0.43-0.50)	1.10 (1.05-1.15)	0.13 (0.11-0.15)	0.25 (0.23-0.28)	0.46 (0.43-0.50)	0.21 (0.19-0.23)	0.33 (0.31-0.36)	1,497.2	0.15 (0.13-0.17)	1,169.7	0.75 (0.70-0.80)
7 to <10	1,513.0	3.11 (3.02-3.20)	0.25 (0.23-0.28)	0.09 (0.08-0.11)	0.34 (0.31-0.37)	1.12 (1.06-1.17)	0.19 (0.17-0.21)	0.40 (0.37-0.43)	0.45 (0.42-0.49)	0.15 (0.14-0.18)	0.28 (0.25-0.31)	1,465.4	0.09 (0.08-0.11)	1,025.4	0.84 (0.78-0.90)
10 to <13	777.7	3.48 (3.35-3.62)	0.17 (0.15-0.21)	0.11 (0.09-0.14)	0.33 (0.29-0.38)	1.27 (1.19-1.35)	0.26 (0.23-0.30)	0.70 (0.64-0.76)	0.52 (0.47-0.57)	0.14 (0.11-0.16)	0.27 (0.24-0.31)	737.8	0.08 (0.07-0.11)	370.4	0.83 (0.74-0.93)
13 to <15	221.6	3.47 (3.23-3.72)	0.14 (0.10-0.20)	0.13 (0.09-0.19)	0.29 (0.23-0.37)	1.40 (1.26-1.57)	0.26 (0.20-0.34)	0.87 (0.76-1.00)	0.47 (0.39-0.57)	0.11 (0.08-0.17)	0.20 (0.15-0.27)	199.6	0.10 (0.06-0.15)	22.0	0.86 (0.55-1.35)
15 to <17	78.9	3.66 (3.27-4.11)	0.16 (0.10-0.28)	0.11 (0.06-0.22)	0.22 (0.13-0.35)	1.33 (1.10-1.61)	0.29 (0.19-0.44)	1.13 (0.92-1.39)	0.66 (0.50-0.87)	0.10 (0.05-0.20)	0.29 (0.19-0.44)	60.3	0.07 (0.02-0.18)	1.0	0
≥17	12.1	4.13 (3.13-5.45)	0	0.17 (0.04-0.66)	0.17 (0.04-0.66)	2.15 (1.46-3.15)	0.58 (0.28-1.21)	1.32 (0.81-2.16)	0.83 (0.44-1.53)	0.08 (0.01-0.59)	0.33 (0.12-0.88)	2.9	0	0.1	0

[1]The indication implant failure, as reported in annual reports up to 2013, has been renamed implant wear as this reflects the wearing down of the implant but distinguishes from the implant itself breaking.
[2]Other indication now includes other indications not listed, implant fracture and incorrect sizing.
[3]Stiffness was asked in versions MDSv2, v3, v6 and v7 of the data collection forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.
[4]Progressive arthritis was asked in versions MDSv3, v6 and v7 of the data collection forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.

3.3.5 Mortality after primary knee replacement surgery

In this section we describe the mortality of the cohort up to 18 years from primary operation, according to gender and age group. Deaths recorded after 31 December 2021 have not been included in the analysis. For simplicity, we have not taken into account whether the patient had a first (or further) joint revision after the primary operation when calculating the cumulative probability of death (see survival analysis methods note in section 3.1). Of the 1,442,051 records of a primary knee replacement, 22,558 unknown knee type records were excluded and there were 14,265 bilateral operations in which the patient had both knees replaced on the same day; here the second of the two has been excluded, leaving 1,256,304 TKR procedures (of whom 267,073 had died before the end of 2021) and 149,346 UKR procedures (of whom 15,476 died before the end of 2021).

Note: These cases were not censored when further revision surgery was undertaken. While such surgery may have contributed to the overall mortality, the impact of this is not investigated in this report. Furthermore, exclusions for unknown knee type and same-day bilateral operations were not mutually exclusive; there was an overlap of 422 cases of unknown knee types with same day bilateral procedures.

Table 3.K12 (a) KM estimates of cumulative mortality (95% CI) by age and gender, in primary TKR. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Age group (years)	N	Time since primary						
		30 days	90 days	1 year	5 years	10 years	15 years	18 years
All cases	1,256,304	0.16 (0.15-0.16)	0.30 (0.29-0.31)	1.02 (1.01-1.04)	8.73 (8.67-8.78)	26.07 (25.96-26.17)	47.92 (47.74-48.11)	61.00 (60.64-61.35)
Male								
<55	30,555	0.04 (0.02-0.07)	0.08 (0.06-0.12)	0.29 (0.24-0.36)	2.17 (2.00-2.35)	6.30 (5.94-6.67)	12.10 (11.37-12.88)	*17.08 (15.43-18.89)*
55 to 59	45,000	0.05 (0.03-0.07)	0.09 (0.07-0.13)	0.36 (0.31-0.42)	2.94 (2.77-3.12)	8.83 (8.48-9.20)	17.92 (17.23-18.65)	25.88 (24.36-27.48)
60 to 64	81,046	0.07 (0.06-0.09)	0.13 (0.11-0.15)	0.46 (0.42-0.51)	4.05 (3.90-4.20)	11.78 (11.49-12.08)	25.51 (24.90-26.13)	37.30 (35.88-38.75)
65 to 69	105,057	0.10 (0.08-0.12)	0.18 (0.15-0.20)	0.68 (0.63-0.73)	5.84 (5.69-6.00)	17.81 (17.50-18.13)	38.04 (37.41-38.67)	53.86 (52.51-55.22)
70 to 74	112,499	0.13 (0.11-0.16)	0.26 (0.24-0.30)	1.04 (0.99-1.11)	9.28 (9.09-9.47)	28.51 (28.14-28.88)	56.66 (56.02-57.29)	74.10 (72.87-75.32)
75 to 79	91,100	0.28 (0.24-0.31)	0.51 (0.47-0.56)	1.77 (1.68-1.86)	15.03 (14.78-15.29)	44.75 (44.30-45.20)	76.57 (75.95-77.17)	*89.02 (88.05-89.95)*
80 to 84	50,754	0.55 (0.49-0.61)	0.96 (0.88-1.05)	2.99 (2.84-3.14)	23.97 (23.56-24.39)	64.14 (63.55-64.74)	91.18 (90.58-91.75)	*97.92 (96.84-98.70)*
≥85	19,535	1.07 (0.93-1.22)	1.91 (1.73-2.11)	5.63 (5.31-5.97)	38.80 (38.04-39.57)	82.41 (81.59-83.21)	*97.16 (96.47-97.75)*	*98.85 (97.42-99.57)*
Female								
<55	43,565	0.03 (0.02-0.05)	0.06 (0.04-0.09)	0.23 (0.19-0.28)	1.65 (1.52-1.78)	4.66 (4.40-4.94)	9.89 (9.29-10.52)	14.87 (13.53-16.34)
55 to 59	59,762	0.03 (0.02-0.05)	0.05 (0.04-0.08)	0.25 (0.21-0.30)	2.11 (1.98-2.24)	6.39 (6.13-6.66)	14.30 (13.73-14.89)	21.52 (20.16-22.96)
60 to 64	96,650	0.03 (0.02-0.05)	0.08 (0.07-0.10)	0.30 (0.27-0.34)	2.77 (2.65-2.88)	8.77 (8.54-9.01)	19.50 (18.99-20.03)	29.74 (28.50-31.02)
65 to 69	130,061	0.06 (0.05-0.08)	0.12 (0.11-0.14)	0.43 (0.40-0.47)	3.97 (3.85-4.08)	12.94 (12.69-13.19)	29.85 (29.32-30.39)	43.40 (42.25-44.57)
70 to 74	147,853	0.10 (0.08-0.11)	0.18 (0.16-0.21)	0.64 (0.60-0.68)	6.02 (5.89-6.16)	20.69 (20.40-20.98)	46.04 (45.49-46.60)	64.56 (63.42-65.69)
75 to 79	130,474	0.15 (0.13-0.18)	0.30 (0.27-0.33)	1.13 (1.07-1.19)	10.20 (10.02-10.38)	33.92 (33.57-34.28)	66.35 (65.80-66.90)	*82.10 (81.15-83.03)*
80 to 84	79,474	0.27 (0.24-0.31)	0.54 (0.49-0.59)	1.86 (1.77-1.96)	16.44 (16.15-16.72)	51.70 (51.22-52.19)	84.81 (84.24-85.37)	*95.55 (94.68-96.32)*
≥85	32,919	0.57 (0.49-0.65)	1.18 (1.06-1.30)	3.46 (3.27-3.67)	28.64 (28.10-29.18)	73.24 (72.55-73.92)	*95.16 (94.58-95.69)*	*99.02 (98.08-99.55)*

Note: Excludes 9,198 bilateral operations performed on the same day.

Tables 3.K12 (a) and (b) above and below, show Kaplan-Meier estimates of cumulative percentage mortality at 30 days, 90 days and at 1, 5, 10, 15 and 18 years following a TKR or UKR, for all cases and by age and gender. Fewer males than females have had a primary knee replacement and, proportionally, more females than males undergo surgery above the age of 75. Males, particularly in the older age groups, had a higher cumulative percentage probability of dying in the short or longer term after their primary knee replacement operation than females in the equivalent age group. The mortality rates are lower in males and females following UKR than TKR, but these figures do not adjust for selection and hence do not account for residual confounding (Hunt et al., 2018).

Table 3.K12 (b) KM estimates of cumulative mortality (95% CI) by age and gender, in primary unicompartmental replacements. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Age group (years)	N	Time since primary						
		30 days	90 days	1 year	5 years	10 years	15 years	18 years
All unicondylar	**133,110**	**0.04 (0.03-0.05)**	**0.08 (0.07-0.10)**	**0.39 (0.36-0.43)**	**4.19 (4.07-4.32)**	**13.28 (13.02-13.54)**	**27.28 (26.77-27.80)**	**37.56 (36.49-38.65)**
Male								
<55	10,860	0.02 (0.00-0.07)	0.04 (0.01-0.10)	0.18 (0.12-0.28)	1.24 (1.03-1.49)	3.64 (3.18-4.16)	8.53 (7.36-9.88)	*12.43 (10.08-15.29)*
55 to 59	11,187	0.03 (0.01-0.08)	0.04 (0.01-0.10)	0.21 (0.14-0.31)	1.84 (1.57-2.15)	6.08 (5.47-6.76)	13.05 (11.79-14.43)	*18.42 (15.88-21.32)*
60 to 64	14,031	0.06 (0.03-0.11)	0.09 (0.05-0.15)	0.35 (0.26-0.47)	2.94 (2.64-3.28)	8.68 (8.06-9.34)	19.40 (18.07-20.81)	*28.06 (25.42-30.92)*
65 to 69	13,481	0.01 (0.00-0.05)	0.05 (0.02-0.10)	0.33 (0.24-0.44)	4.26 (3.89-4.67)	14.22 (13.40-15.09)	29.79 (28.14-31.52)	*43.21 (39.74-46.85)*
70 to 74	10,863	0.02 (0.00-0.07)	0.07 (0.03-0.14)	0.59 (0.46-0.76)	7.03 (6.48-7.62)	22.61 (21.44-23.83)	49.18 (46.91-51.50)	*65.35 (60.81-69.85)*
75 to 79	6,833	0.07 (0.03-0.18)	0.21 (0.12-0.35)	1.06 (0.84-1.34)	11.29 (10.43-12.22)	37.62 (35.88-39.41)	*70.64 (67.94-73.30)*	*84.66 (80.70-88.19)*
80 to 84	3,082	0.10 (0.03-0.30)	0.26 (0.13-0.52)	1.92 (1.48-2.49)	19.64 (18.01-21.39)	53.58 (50.84-56.36)	*85.67 (82.41-88.61)*	*96.42 (90.89-99.02)*
≥85	1,015	0.49 (0.21-1.18)	0.79 (0.40-1.58)	3.35 (2.38-4.70)	35.18 (31.74-38.88)	*80.72 (76.47-84.62)*	*96.48 (92.41-98.70)*	*98.24 (93.23-99.77)*
Female								
<55	12,266	0.02 (0.00-0.07)	0.02 (0.01-0.08)	0.06 (0.03-0.12)	0.80 (0.64-1.00)	2.59 (2.22-3.02)	5.42 (4.63-6.34)	*8.54 (6.62-10.97)*
55 to 59	10,096	0.01 (0.00-0.07)	0.01 (0.00-0.07)	0.06 (0.03-0.14)	1.06 (0.85-1.31)	3.71 (3.22-4.27)	8.11 (7.11-9.25)	*12.99 (10.63-15.82)*
60 to 64	10,660	0.01 (0.00-0.07)	0.01 (0.00-0.07)	0.13 (0.07-0.22)	1.76 (1.50-2.07)	5.78 (5.20-6.42)	13.47 (12.18-14.90)	*23.88 (20.46-27.76)*
65 to 69	10,335	0.03 (0.01-0.09)	0.08 (0.04-0.16)	0.24 (0.16-0.36)	2.47 (2.16-2.84)	8.33 (7.60-9.13)	20.55 (18.87-22.35)	*31.73 (27.95-35.89)*
70 to 74	8,924	0.06 (0.02-0.13)	0.10 (0.05-0.19)	0.35 (0.25-0.50)	3.91 (3.47-4.41)	13.86 (12.82-14.98)	33.78 (31.65-36.02)	*50.15 (45.41-55.10)*
75 to 79	5,806	0.00 (.-.)	0.05 (0.02-0.16)	0.35 (0.22-0.54)	6.72 (6.00-7.52)	25.00 (23.40-26.69)	53.97 (51.15-56.84)	*68.65 (62.66-74.49)*
80 to 84	2,702	0.11 (0.04-0.34)	0.30 (0.15-0.60)	1.16 (0.81-1.66)	11.85 (10.50-13.35)	42.43 (39.77-45.19)	*77.58 (73.93-81.03)*	*92.23 (85.92-96.42)*
≥85	969	0.31 (0.10-0.96)	0.83 (0.42-1.66)	2.82 (1.93-4.12)	21.18 (18.31-24.43)	*63.29 (58.51-68.07)*	*95.63 (89.10-98.80)*	*100 (.-.)*
All patellofemoral	**15,641**	**0.04 (0.02-0.09)**	**0.12 (0.08-0.19)**	**0.37 (0.29-0.48)**	**3.57 (3.27-3.90)**	**11.23 (10.61-11.89)**	**22.99 (21.71-24.34)**	*30.21 (27.34-33.31)*
All multicompartmental	**595**	**0.00 (.-.)**	**0.00 (.-.)**	**0.35 (0.09-1.40)**	**2.45 (1.43-4.19)**	**7.99 (5.72-11.09)**	*17.17 (10.42-27.57)*	*17.17 (10.42-27.57)*

Note: Excludes 4,645 bilateral operations performed on the same day.

Hunt LP, Whitehouse MR, Howard PW, Ben-Shlomo Y, Blom AW. Using long term mortality to determine which peri-operative risk factors of mortality following hip and knee replacement may be causal. Sci Rep. 2018 Oct 9;8(1):15026.

3.3.6 Overview of knee revisions

In this section we look at all recorded knee revision procedures performed since the registry began on 1 April 2003 up to the end of December 2021, for all patients with valid patient identifiers (i.e. whose data could be linked).

In total there were 92,919 revisions recorded on 76,797 individual patient-sides (72,991 actual patients). In addition to the 43,838 revised primaries described previously in this section, there were 38,994 additional revisions for a patient-side for which there is no associated primary operation recorded in the registry.

We have classified revisions as single-stage, stage one of two-stage, or stage two of two-stage revisions. Information on stage one and stage two of two-stage revisions are entered into the registry separately. Debridement and Implant Retention (DAIR) with or without modular exchange are included as single-stage procedures. With the introduction of distinct indicators for the DAIR procedures in MDSv7, it may be possible to report these as distinct categories in future reports. Not all patients who undergo stage one of a two-stage revision will undergo a stage two of two-stage revision. In some cases, stage one revisions have been entered without stage two, and vice versa, making identification of entire patient revision episodes difficult. We have attempted to address this later in this section.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

Table 3.K13 (page 192) gives an overview of all knee revision procedures carried out each year since April 2003. There were a maximum of 15 documented revision procedures associated with any individual patient-side. The increase in the number of operations over time, until 2020 when rates were impacted by COVID-19, reflects the increasing number of at-risk implants prevailing in the dataset.

Table 3.K13 Number and percentage of revisions by procedure type and year.

Year of revision surgery	Type of revision procedure			Total revision joint operations
	Single-stage N(%)	Stage one of two-stage N(%)	Stage two of two-stage N(%)	
2003*	7 (1.1)	<4 (0.2)	632 (98.8)	640
2004	712 (57.1)	78 (6.3)	457 (36.6)	1,247
2005	1,487 (73.7)	211 (10.5)	321 (15.9)	2,019
2006	1,948 (75.3)	282 (10.9)	357 (13.8)	2,587
2007	2,663 (75.2)	387 (10.9)	493 (13.9)	3,543
2008	3,331 (75.7)	473 (10.8)	596 (13.5)	4,400
2009	3,716 (76.3)	527 (10.8)	629 (12.9)	4,872
2010	4,180 (77.1)	573 (10.6)	670 (12.4)	5,423
2011	4,341 (77.4)	620 (11.0)	650 (11.6)	5,611
2012	5,013 (78.5)	631 (9.9)	741 (11.6)	6,385
2013	4,706 (78.5)	631 (10.5)	661 (11.0)	5,998
2014	5,082 (78.0)	736 (11.3)	700 (10.7)	6,518
2015	5,349 (79.0)	746 (11.0)	676 (10.0)	6,771
2016	5,565 (80.6)	699 (10.1)	643 (9.3)	6,907
2017	5,667 (80.6)	701 (10.0)	667 (9.5)	7,035
2018	5,686 (82.2)	627 (9.1)	604 (8.7)	6,917
2019	5,943 (83.3)	639 (9.0)	549 (7.7)	7,131
2020	3,220 (79.7)	456 (11.3)	365 (9.0)	4,041
2021	4,075 (83.6)	403 (8.3)	396 (8.1)	4,874
Total	72,691	9,421	10,807	92,919

*Incomplete year.

Table 3.K14 (a) shows the stated indications for the revision knee surgery. As more than one reason can be selected, the indications are not mutually exclusive and therefore column percentages do not add up to 100%. Aseptic loosening / lysis is the most common indication for revision, accounting for approximately 40% of single-stage revision operations, while instability, pain, wear and other indications account for between 10% and 20% each. Of the two-stage revision operations, infection is the main indication recorded in approximately 80% of either stage one or stage two procedures. Table 3.K14 (b) presents these results, restricted to the last five years.

Table 3.K14 (a) Number and percentage of knee revision by indication and procedure type.

Reason for revision	Type of revision procedure		
	Single-stage N(%) (n=72,691)	Stage one of two-stage N(%) (n=9,421)	Stage two of two-stage N(%) (n=10,807)
Aseptic loosening / Lysis	27,573 (37.9)	1,638 (17.4)	1,803 (16.7)
Instability	12,548 (17.3)	374 (4.0)	517 (4.8)
Pain	10,394 (14.3)	371 (3.9)	536 (5.0)
Implant wear	10,177 (14.0)	297 (3.2)	319 (3.0)
Other indication	8,017 (11.0)	342 (3.6)	636 (5.9)
Infection	5,774 (7.9)	8,042 (85.4)	8,078 (74.7)
Malalignment	5,244 (7.2)	114 (1.2)	179 (1.7)
Periprosthetic fracture	3,441 (4.7)	138 (1.5)	167 (1.5)
Dislocation / Subluxation	2,940 (4.0)	147 (1.6)	143 (1.3)
Stiffness*	4,103 (5.6) n=72,691	204 (2.2) n=9,421	170 (1.7) n=9,884
Progressive arthritis*	10,090 (15.4) n=65,411	66 (0.8) n=8,390	97 (1.1) n=8,449

*These reasons were not recorded in the earliest phase of the registry; only in MDSv2 onwards for stiffness and MDSv3 onwards for progressive arthritis.
Note: The number of joints on which these two percentages are based is stated beside the percentage figure.
Note: Indications listed are not mutally exclusive.

Table 3.K14 (b) Number and percentage of knee revision by indication and procedure type in the last five years.

Reason for revision	Type of revision procedure		
	Single-stage N(%) (n=24,592)	Stage one of two-stage N(%) (n=2,826)	Stage two of two-stage N(%) (n=2,581)
Aseptic loosening / Lysis	8,020 (32.6)	393 (13.9)	271 (10.5)
Progressive arthritis	5,123 (20.8)	24 (0.8)	52 (2.0)
Instability	4,234 (17.2)	86 (3.0)	62 (2.4)
Implant wear	3,296 (13.4)	66 (2.3)	37 (1.4)
Infection	2,993 (12.2)	2,532 (89.6)	2,175 (84.3)
Other indication	2,104 (8.6)	72 (2.5)	106 (4.1)
Pain	2,035 (8.3)	38 (1.3)	35 (1.4)
Periprosthetic fracture	1,551 (6.3)	37 (1.3)	48 (1.9)
Malalignment	1,475 (6.0)	22 (0.8)	25 (1.0)
Stiffness	1,304 (5.3)	31 (1.1)	34 (1.3)
Dislocation / Subluxation	936 (3.8)	40 (1.4)	20 (0.8)

Note: Indications listed are not mutally exclusive.

3.3.7 Rates of knee re-revision

In most instances (86%), the first revision procedure was a single-stage revision, in the remaining 14% it was part of a two-stage procedure. For a given patient-side, the survival following the first documented revision procedure linked to a primary in the registry (n=43,838) has been analysed. This analysis is restricted to patients with a linked primary procedure so that there is confidence that the next observed procedure on the same joint is the first revision episode. If there is no linked primary record in the dataset, it cannot be determined if the first observed revision is the first revision or has been preceded by other revision episodes. The time from the first documented revision procedure (of any type) to the time at which a second revision procedure was undertaken has been determined. For this purpose, an initial stage one followed by either a stage one or a stage two of a two-stage procedure have been considered to be the same revision episode and these were disregarded, looking instead for the start of a second revision episode.

The maximum number of distinct revision episodes for any patient-side was determined to be 14. In cases where a stage one of two procedure was followed by a stage two of two procedure within 365 days, we have treated this as a single distinct episode. This definition allows multiple stage one procedures to occur before a new revision episode is triggered. In situations where the first stage one procedure is not followed by a stage two procedure within a 365-day period, the next occurrence of a stage one procedure was considered as a new revision episode.

Kaplan-Meier estimates of the cumulative percentage probability of having a subsequent revision (re-revision) were calculated. There were 4,940 re-revisions and for 6,315 cases the patient died without having been re-revised. The censoring date for the remainder was the end of 2021.

Figure 3.K6 (a) KM estimates of cumulative re-revision, in linked primary knee replacements (shaded area indicates point-wise 95% CI). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

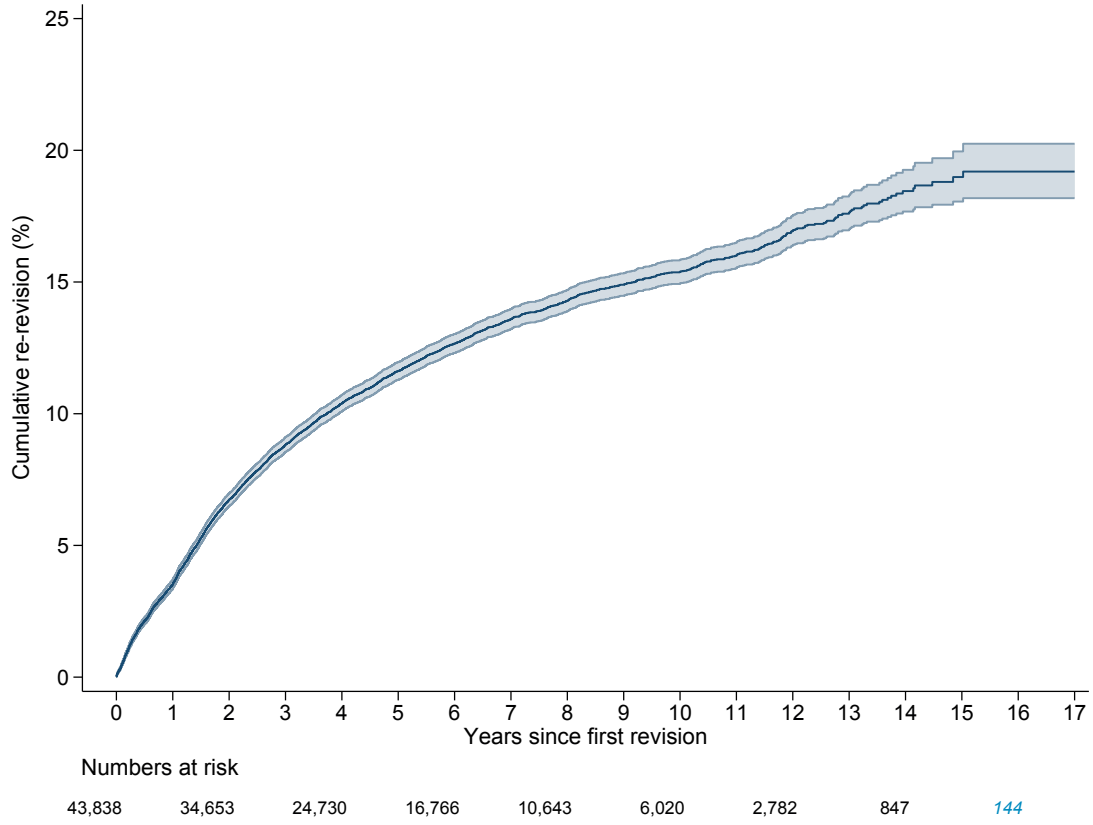
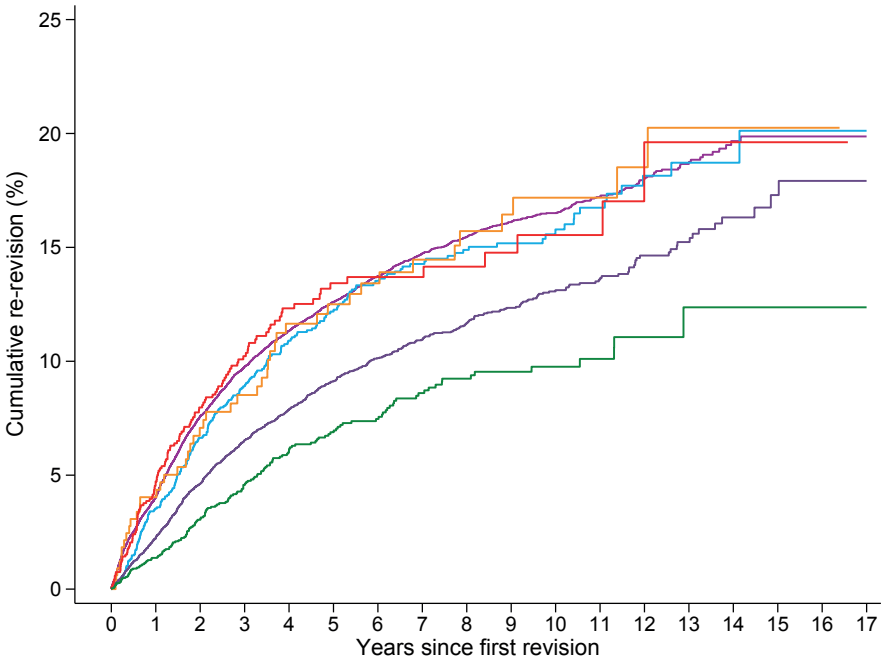


Figure 3.K6 (a) plots Kaplan-Meier estimates of the cumulative probability of a subsequent revision in linked revised primary knee replacements as between 1 and 17 years since the primary operation.

Figure 3.K6 (b) shows estimates of re-revision by type of primary knee replacement. Revised patellofemoral knee replacements have the lowest risk of re-revision until ten years, after which the numbers at risk fall below 250 and should be interpreted with caution. Revised cemented unicondylar knee replacements have the next lowest risk of re-revision until 14 years when again, the numbers at risk become small.

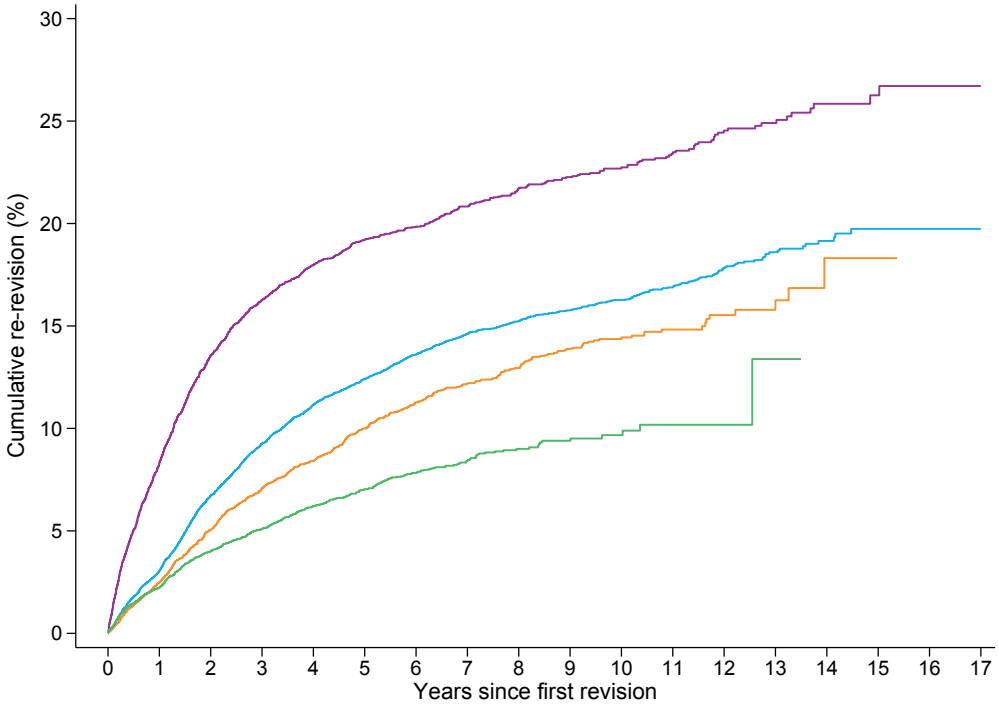
Revised uncemented / hybrid unicondylar knee replacements appear to have a higher risk of re-revision than their cemented counterparts and are equivalent to the rates seen for revised cemented TKRs until five years, after which the numbers in the revised uncemented unicondylar group become small.

Figure 3.K6 (b) KM estimates of cumulative re-revision by primary fixation, in linked primary knee replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
Cemented	28,847	22,348	15,561	10,199	6,219	3,397	1,529	442	*66*
Uncemented	1,774	1,493	1,185	870	629	390	*187*	*64*	*10*
Hybrid	333	267	*219*	*180*	*129*	*89*	*47*	*14*	*<4*
Unicondylar, cemented	8,233	6,835	5,183	3,750	2,534	1,530	761	265	*51*
Unicondylar, uncemented/hybrid	1,211	841	459	251	*153*	*75*	*31*	*9*	*<4*
Patellofemoral	2,263	1,899	1,387	974	612	325	*120*	*27*	*5*

Figure 3.K6 (c) KM estimates of cumulative re-revision by years to first revision, in linked primary knee replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



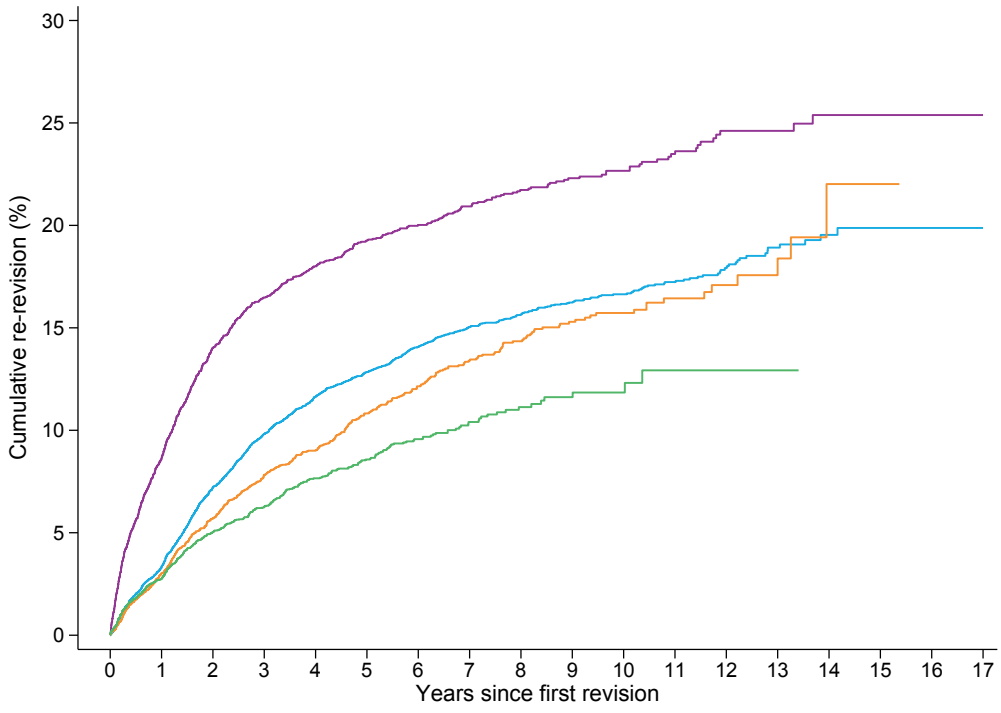
Key:

Numbers at risk																		
First rev. <1y	6,868	5,929	5,266	4,473	3,868	3,304	2,836	2,366	1,983	1,619	1,299	1,029	746	493	287	*162*	*73*	*24*
First rev. 1 to 3y	15,465	14,285	13,096	11,527	10,139	8,824	7,479	6,257	5,176	4,226	3,220	2,387	1,587	947	510	*227*	*71*	*6*
First rev. 3 to 5y	8,000	7,158	6,486	5,589	4,733	3,940	3,279	2,694	2,134	1,622	1,089	681	384	*181*	*50*	*<4*		
First rev. ≥5y	13,505	11,301	9,805	7,803	5,990	4,444	3,172	2,150	1,350	828	412	*177*	*65*	*9*				

Figure 3.K6 (c) shows the relationship between time to first revision and risk of subsequent revision. The earlier the primary knee replacement is revised, the higher the risk of second revision. For example, if a primary knee replacement is revised within the first year of the primary replacement being performed, there is an 8.3% (95% CI 7.6-9.0) re-revision estimate at one year following the first revision, rising to 19.2% (95% CI 18.2-20.2) by five years; if a primary knee replacement is not revised until five years or more after the primary procedure, the re-revision rate is 2.2% (95% CI 2.0-2.5) at one year following the first revision, rising to 7.0% (95% CI 6.5-7.6) by five years.

For those with documented primary knee replacements within the registry, Figures 3.K7 (a) to (f) show cumulative re-revision rates following the first revision, according to the main type of primary knee replacement. We have further sub-divided each sub-group according to the time interval from the primary to the first revision, i.e. less than 1 year, 1 to <3, 3 to <5 and greater than or equal to 5 years. For cemented TKRs, uncemented TKRs, unicondylar and patellofemoral knee replacements, those who had their first revision within one year of the initial primary knee replacement experienced the worst re-revision rates. However, for hybrid TKRs, the worst re-revision rates were experienced by those who had their first revision within three to five years of the initial primary knee replacement. However, the numbers at risk were small in the hybrid group and therefore we advise that the results should be interpreted with caution.

Figure 3.K7 (a) KM estimates of cumulative re-revision in primary cemented TKRs by years to first revision.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.

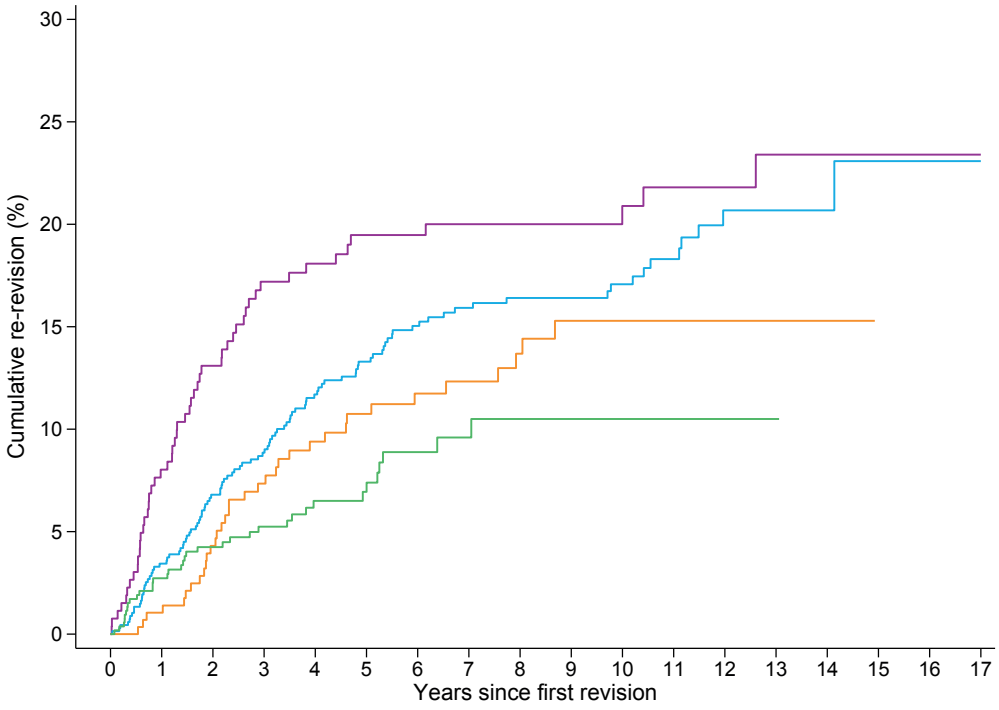


Key:

Numbers at risk

First rev. <1y	4,907	4,189	3,697	3,108	2,653	2,218	1,855	1,511	1,224	971	750	566	392	253	*140*	*76*	*30*	*7*
First rev. 1 to 3y	10,883	9,979	9,064	7,876	6,804	5,782	4,807	3,937	3,158	2,507	1,869	1,379	901	529	276	*109*	*36*	*<4*
First rev. 3 to 5y	5,421	4,768	4,259	3,574	2,950	2,384	1,919	1,535	1,191	888	589	357	*206*	*100*	*26*	*<4*		
First rev. ≥5y	7,636	6,248	5,328	4,177	3,154	2,319	1,618	1,067	646	388	*189*	*80*	*30*	*<4*				

Figure 3.K7 (b) KM estimates of cumulative re-revision in primary uncemented TKRs by years to first revision. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

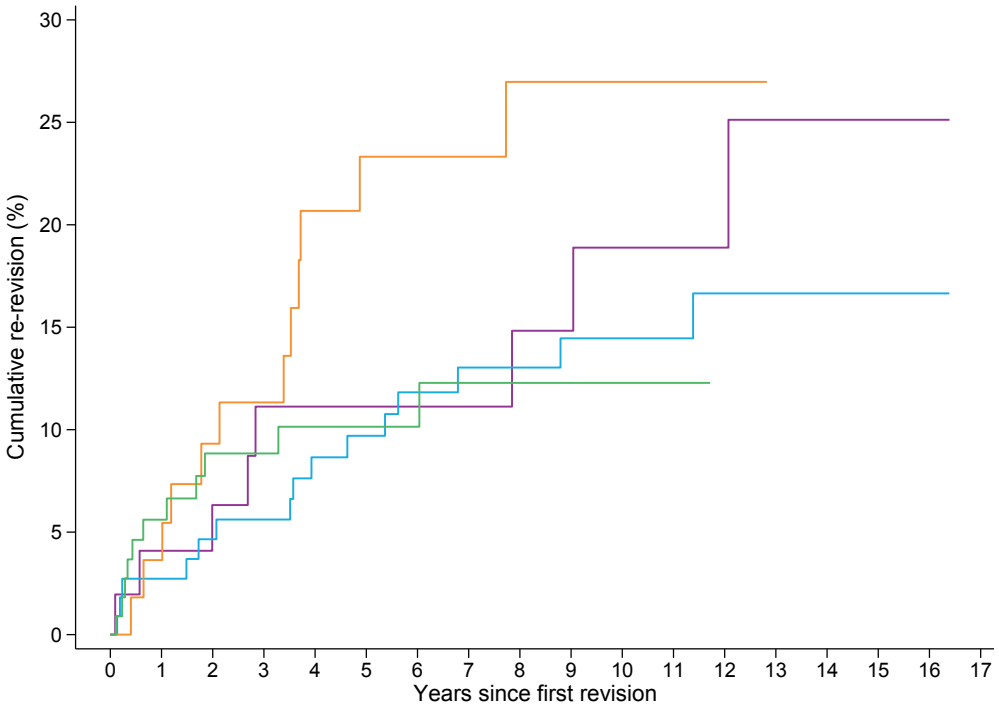


Key:

Numbers at risk

First rev. <1y	265	*237*	*219*	*198*	*183*	*167*	*153*	*141*	*128*	*109*	*89*	*76*	*59*	*39*	*25*	*16*	*6*	*<4*
First rev. 1 to 3y	678	639	604	555	513	468	406	358	325	281	*226*	*162*	*108*	*64*	*37*	*15*	*4*	*<4*
First rev. 3 to 5y	291	282	260	*233*	*209*	*188*	*169*	*144*	*119*	*86*	*56*	*32*	*17*	*9*	*<4*			
First rev. ≥5y	540	464	410	354	280	*206*	*142*	*101*	*57*	*38*	*19*	*11*	*<4*	*<4*				

Figure 3.K7 (c) KM estimates of cumulative re-revision in primary hybrid TKRs by years to first revision. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

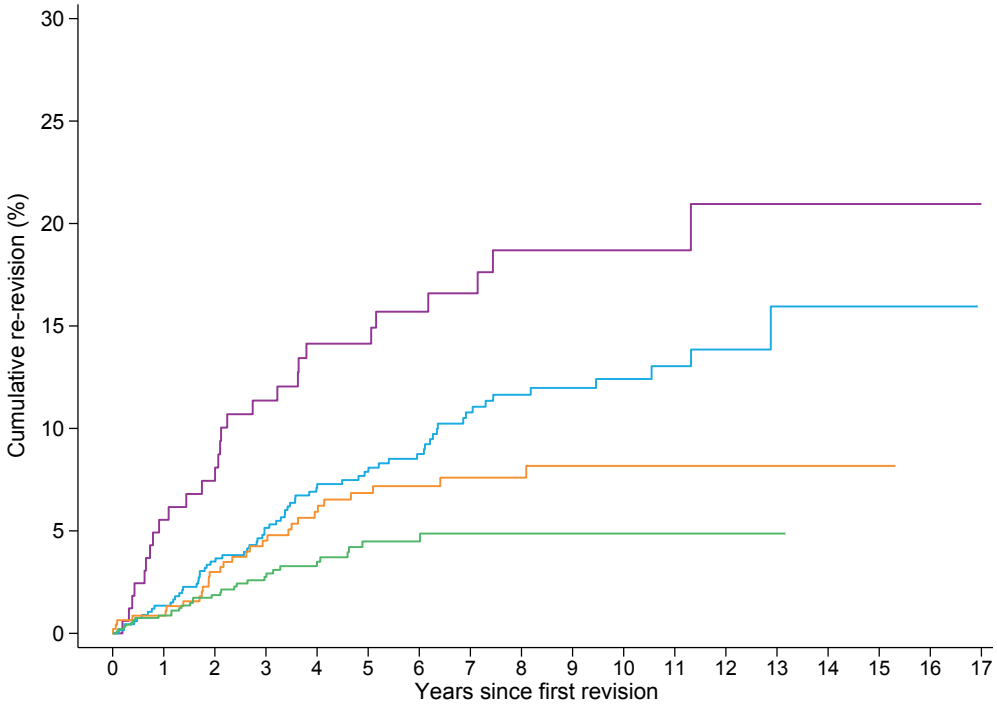


Key:

Numbers at risk

First rev. <1y	*52*	*45*	*42*	*36*	*36*	*34*	*30*	*26*	*23*	*21*	*18*	*16*	*13*	*7*	*<4*	*<4*	*<4*
First rev. 1 to 3y	*111*	*106*	*99*	*96*	*89*	*85*	*82*	*71*	*64*	*60*	*51*	*42*	*30*	*16*	*11*	*4*	*<4*
First rev. 3 to 5y	*55*	*53*	*45*	*43*	*33*	*29*	*25*	*23*	*19*	*15*	*10*	*6*	*4*				
First rev. ≥5y	*115*	*93*	*81*	*70*	*61*	*55*	*43*	*31*	*23*	*17*	*10*	*4*					

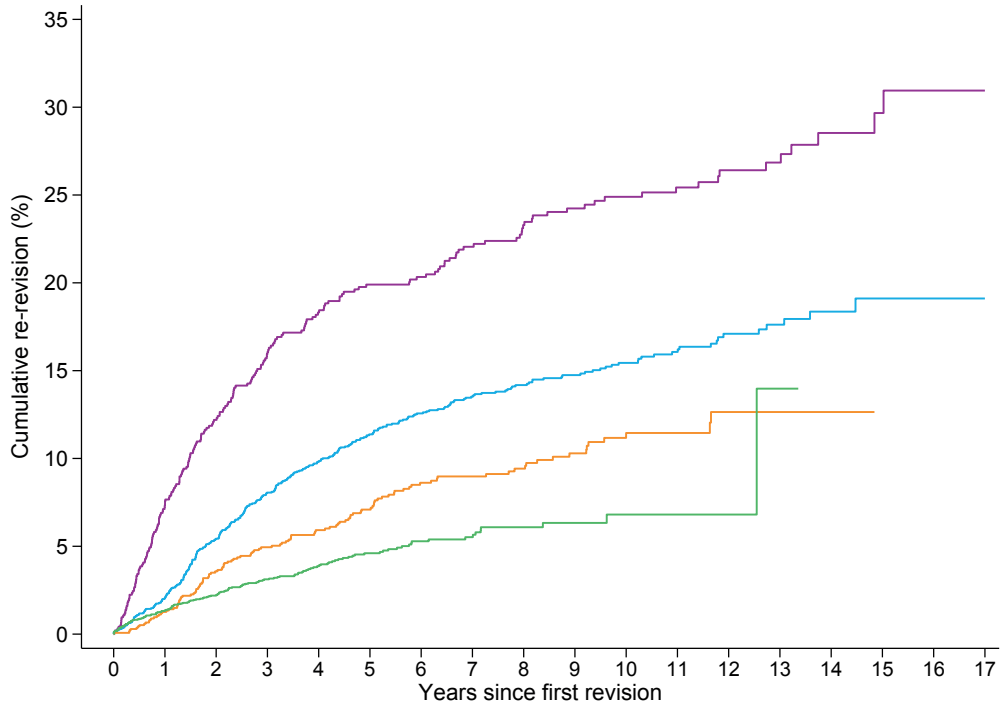
Figure 3.K7 (d) KM estimates of cumulative re-revision in primary patellofemoral knee replacements by years to first revision. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk																	
First rev. <1y	*165*	*152*	*143*	*130*	*122*	*111*	*100*	*84*	*72*	*59*	*47*	*38*	*26*	*15*	*8*	*4*	*<4*	*<4*
First rev. 1 to 3y	676	648	616	558	499	454	386	324	271	*225*	*169*	*125*	*69*	*38*	*17*	*9*	*<4*	
First rev. 3 to 5y	467	427	399	354	317	276	*240*	*201*	*164*	*132*	*82*	*49*	*24*	*9*	*<4*	*<4*		
First rev. ≥5y	955	835	741	582	449	333	*248*	*155*	*105*	*61*	*27*	*13*	*<4*	*<4*				

Figure 3.K7 (e) KM estimates of cumulative re-revision in primary cemented unicondylar knee replacements by years to first revision. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

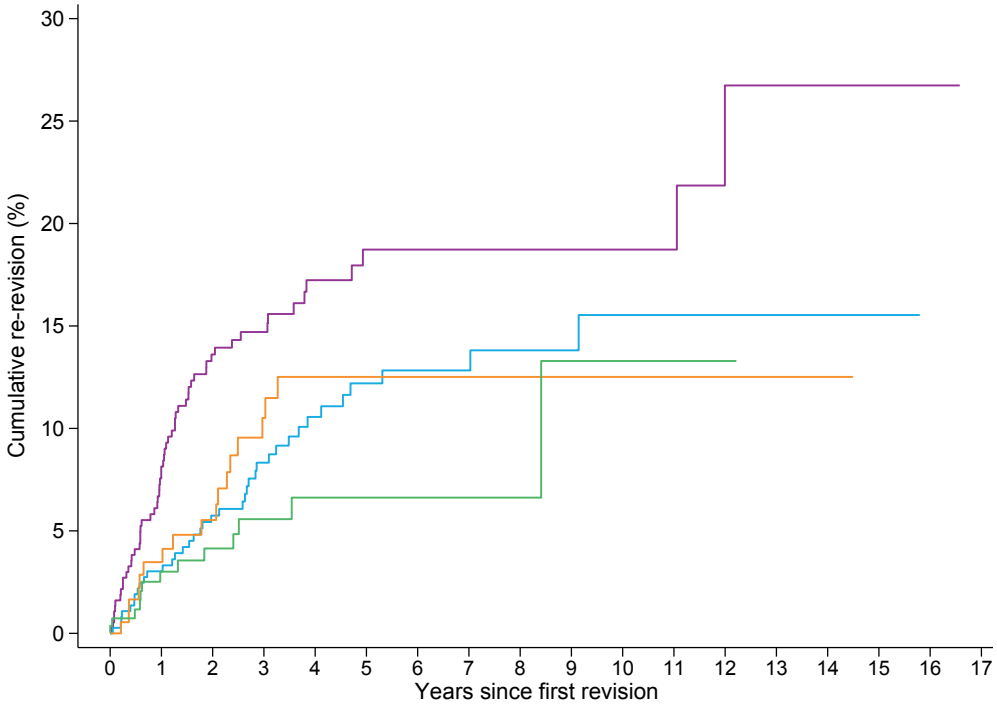


Key:

Numbers at risk

First rev. <1y	941	849	777	694	631	581	541	471	422	360	313	264	*206*	*151*	*97*	*55*	*27*	*12*
First rev. 1 to 3y	2,397	2,253	2,111	1,935	1,795	1,638	1,453	1,273	1,104	942	755	574	413	260	*149*	*79*	*24*	*4*
First rev. 3 to 5y	1,386	1,305	1,228	1,131	1,011	889	785	680	562	447	317	*213*	*117*	*55*	*19*			
First rev. ≥5y	3,509	3,040	2,719	2,229	1,746	1,318	971	692	446	282	*145*	*58*	*25*	*<4*				

Figure 3.K7 (f) KM estimates of cumulative re-revision in primary uncemented / hybrid unicondylar knee replacements by years to first revision. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

Numbers at risk

First rev. <1y	374	316	263	*195*	*141*	*102*	*73*	*54*	*44*	*40*	*31*	*26*	*15*	*7*	*<4*	*<4*	*<4*
First rev. 1 to 3y	373	335	298	*225*	*175*	*148*	*111*	*90*	*75*	*55*	*34*	*21*	*11*	*9*	*6*	*4*	
First rev. 3 to 5y	*191*	*149*	*124*	*92*	*67*	*47*	*33*	*24*	*18*	*13*	*6*	*6*	*4*	*<4*	*<4*		
First rev. ≥5y	273	*197*	*156*	*111*	*76*	*54*	*34*	*23*	*16*	*10*	*4*	*4*	*<4*				

Table 3.K15 (a) KM estimates of cumulative re-revision (95% CI). *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

	Number of first revised joints at risk of re-revision	Time since first revision				
		1 year	3 years	5 years	10 years	15 years
Primary recorded in the registry	43,838	3.54 (3.36-3.72)	8.82 (8.54-9.11)	11.62 (11.29-11.96)	15.40 (14.95-15.85)	18.98 (18.05-19.96)

Note: Data are not presented for 18 years due to low numbers.

Table 3.K15 (a) shows the re-revision rate of the 43,838 revised primary knee replacements (42,733 (97.5%) with known knee type at primary procedure) that are registered in the registry. Of these, 4,940 were re-revised.

Table 3.K15 (b) shows that primary knee replacements that are revised within the first year after surgery have approximately two to four times the chance of needing re-revision at each time point compared with primaries that last more than five years.

Table 3.K15 (b) KM estimates of cumulative re-revision (95% CI) by years since first revision. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Primary in the registry where the first revision took place:	Number of first revised joints at risk of re-revision	Time since first revision				
		1 year	3 years	5 years	10 years	15 years
<1 year after primary	6,868	8.27 (7.63-8.95)	16.27 (15.38-17.20)	19.22 (18.24-20.24)	22.74 (21.59-23.94)	*26.26 (24.50-28.12)*
1 to <3 years after primary	15,465	3.05 (2.79-3.34)	9.26 (8.80-9.75)	12.41 (11.86-12.98)	16.27 (15.58-16.98)	*19.74 (18.53-21.01)*
3 to <5 years after primary	8,000	2.49 (2.17-2.87)	7.08 (6.50-7.70)	9.99 (9.28-10.76)	14.44 (13.43-15.53)	
≥5 years after primary*	13,505	2.24 (2.00-2.51)	5.10 (4.70-5.52)	7.02 (6.51-7.56)	9.67 (8.83-10.60)	

*The maximum of this interval was 18.5 years.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Data are not presented for 18 years due to low numbers.

Table 3.K15 (c) shows cumulative re-revision rates at 1, 3, 5, 10 and 15 years following the first revision for those with documented primary knee replacements within the registry, broken down by type of knee replacement, constraint, mobility and whether a patellar component was recorded. Overall, the worst re-revision rates were demonstrated in those where the initial primary had been a cemented TKR, hybrid TKR or an uncemented unicondylar although the confidence intervals broadly overlap after five years in the cemented TKR group and earlier in the other groups.

Table 3.K15 (c) KM estimates of cumulative re-revision (95% CI) by fixation and constraint and whether a patella component was recorded. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Fixation, constraint and bearing type	N	Time since first revision				
		1 year	3 years	5 years	10 years	15 years
All types	**43,838**	**3.54 (3.36-3.72)**	**8.82 (8.54-9.11)**	**11.62 (11.29-11.96)**	**15.40 (14.95-15.85)**	**18.98 (18.05-19.96)**
Unconfirmed	**1,105**	**3.09 (2.21-4.32)**	**8.90 (7.29-10.83)**	**11.49 (9.61-13.72)**	***13.48 (11.27-16.10)***	***14.18 (11.67-17.17)***
Cemented	**28,847**	**4.04 (3.81-4.28)**	**9.77 (9.41-10.14)**	**12.61 (12.19-13.05)**	**16.50 (15.94-17.09)**	***19.87 (18.75-21.05)***
unconstrained, fixed, with patella	5,399	5.05 (4.48-5.68)	10.97 (10.11-11.90)	13.61 (12.61-14.68)	17.46 (16.14-18.88)	*21.19 (18.49-24.23)*
unconstrained, fixed, without patella	12,426	3.54 (3.22-3.89)	9.15 (8.63-9.71)	12.14 (11.50-12.80)	15.33 (14.51-16.19)	*18.07 (16.57-19.68)*
unconstrained, mobile, without patella	1,057	3.46 (2.49-4.78)	9.45 (7.76-11.49)	12.57 (10.56-14.92)	*19.24 (16.43-22.47)*	
posterior-stabilised, fixed, with patella	3,557	4.73 (4.06-5.50)	10.32 (9.29-11.45)	13.38 (12.16-14.71)	17.63 (15.95-19.45)	*25.24 (20.50-30.85)*
posterior-stabilised, fixed, without patella	4,720	3.42 (2.93-3.99)	8.91 (8.08-9.82)	11.35 (10.38-12.41)	15.27 (13.93-16.73)	*17.30 (15.26-19.58)*
Uncemented	**1,774**	**3.53 (2.76-4.52)**	**8.91 (7.63-10.39)**	**12.18 (10.65-13.92)**	**15.79 (13.88-17.93)**	***20.12 (16.57-24.31)***
unconstrained, fixed, without patella	614	3.36 (2.18-5.15)	9.67 (7.50-12.41)	13.79 (11.12-17.05)	*17.37 (14.12-21.26)*	
unconstrained, mobile, without patella	836	4.04 (2.89-5.64)	8.13 (6.42-10.27)	10.71 (8.69-13.16)	*14.52 (11.94-17.59)*	*17.85 (13.98-22.66)*
Hybrid	**333**	**4.03 (2.36-6.85)**	***8.52 (5.87-12.28)***	***12.50 (9.16-16.96)***	***17.18 (12.90-22.70)***	
Unicondylar, cemented	**8,233**	**2.26 (1.96-2.61)**	**6.53 (5.99-7.11)**	**9.12 (8.46-9.84)**	**13.12 (12.20-14.11)**	***17.30 (15.32-19.50)***
fixed	1,794	2.25 (1.64-3.08)	7.63 (6.40-9.09)	10.36 (8.84-12.12)	*14.84 (12.68-17.32)*	
mobile	5,784	2.37 (2.01-2.81)	6.38 (5.75-7.08)	8.84 (8.07-9.67)	12.85 (11.78-14.01)	*16.94 (14.66-19.53)*
monobloc polyethylene tibia	655	1.27 (0.64-2.53)	5.05 (3.56-7.15)	8.56 (6.49-11.26)	*11.41 (8.78-14.77)*	*13.64 (9.83-18.76)*
Unicondylar, uncemented/hybrid	**1,211**	**4.73 (3.63-6.14)**	**10.23 (8.49-12.30)**	**13.43 (11.26-15.98)**	***15.54 (12.66-19.01)***	
mobile	1,092	4.95 (3.77-6.48)	10.23 (8.41-12.43)	13.63 (11.29-16.40)	*14.56 (11.95-17.68)*	
Patellofemoral	**2,263**	**1.37 (0.96-1.95)**	**4.58 (3.74-5.59)**	**6.89 (5.80-8.16)**	**9.76 (8.28-11.49)**	***12.37 (9.44-16.13)***

Note: Maximum follow-up period was 17.9 years.

3.3.8 Reasons for knee re-revision

Table 3.K16 (a) Number of revisions by indication for all revisions.

Reason for revision	All recorded revisions, N(%)
Aseptic loosening / Lysis	31,014 (33.4)
Infection	21,894 (23.6)
Instability	13,439 (14.5)
Pain	11,301 (12.2)
Implant wear	10,793 (11.6)
Malalignment	5,537 (6.0)
Periprosthetic fracture	3,746 (4.0)
Dislocation / Subluxation	3,230 (3.5)
Other indication	8,995 (9.7)
Stiffness*	4,477 (4.9)
Progressive Arthritis**	10,253 (12.5)

*Stiffness as a reason for revision was not recorded in MSDv1 and as such was only a potential reason for revision among a total of 91,996 revisions as opposed to 92,919 revisions for the other reasons.
**Progressive arthritis as a reason for revision was not recorded in MSDv1 or MSDv2 and as such was only a potential reason for revision among a total of 82,250 revisions, as opposed to 92,919 revisions for the other reasons.

Table 3.K16 (b) Number of revisions by indication for first linked revision and second linked re-revision.

	First linked revision		Second linked revision
Reason for revision	N	Subsequently re-revised, N(%)	N
Aseptic loosening / Lysis	11,715	1,167 (10.0)	1,241
Infection	8,451	1,613 (19.1)	1,937
Pain	6,273	716 (11.4)	475
Instability	6,183	662 (10.7)	853
Malalignment	3,049	284 (9.3)	261
Implant wear	2,940	270 (9.2)	204
Periprosthetic fracture	1,750	129 (7.4)	129
Dislocation / Subluxation	1,568	229 (14.6)	205
Other indication	4,663	476 (10.2)	364
Stiffness*	2,623	309 (11.8)	302
Progressive Arthritis**	5,423	270 (5.0)	136

*Stiffness as a reason for revision was not recorded in MSDv1 and as such was only a potential reason for revision among a total of 42,704 revisions as opposed to 43,838 revisions for the other reasons.
**Progressive arthritis as a reason for revision was not recorded in MSDv1 or MSDv2 and as such was only a potential reason for revision among a total of 32,483 revisions, as opposed to 43,838 revisions for the other reasons.

Tables 3.K16 (a) and (b) (page 206) show a breakdown of the stated indications for the first revision and for any second revision. Please note the indications are not mutually exclusive. Table 3.K16 (a) shows the indications for all knee revisions recorded in the registry and Table 3.K16 (b) reports the indications for the first linked revision and the number and percentage of first recorded revisions that were subsequently re-revised. The final column reports the indications for all the second linked revisions. It is interesting to note that infection, dislocation / subluxation, instability and stiffness are more common indications for second revision than for a first revision. This reflects the factors that infection, surgical complexity and soft tissue elements contribute to the outcome of revision knee replacement.

Table 3.K17 (a) Number of revisions by year.

Year of first revision in the registry*	Number of first revisions	Number of first revisions (%) with the associated primary recorded in the registry
2003	632	12 (1.9)
2004	1,190	84 (7.1)
2005	1,860	282 (15.2)
2006	2,343	511 (21.8)
2007	3,165	888 (28.1)
2008	3,815	1,394 (36.5)
2009	4,193	1,834 (43.7)
2010	4,610	2,214 (48.0)
2011	4,691	2,366 (50.4)
2012	5,299	2,983 (56.3)
2013	4,911	2,852 (58.1)
2014	5,253	3,242 (61.7)
2015	5,415	3,533 (65.2)
2016	5,509	3,780 (68.6)
2017	5,607	3,989 (71.1)
2018	5,525	4,114 (74.5)
2019	5,754	4,362 (75.8)
2020	3,133	2,390 (76.3)
2021	3,892	3,008 (77.3)
Total	76,797	43,838 (57.1)

*First documented revision in the registry.

Table 3.K17 (b) Number of revisions by year, stage, and whether or not primary is recorded in the registry.

Year of (first) revision	Single-stage		First documented stage of two-stage	
	Primary not in the registry total per year	Primary in the registry total per year	Primary not in the registry total per year	Primary in the registry total per year
2003	5	<4	615	10
2004	656	48	450	36
2005	1,245	204	333	78
2006	1,494	386	338	125
2007	1,878	672	399	216
2008	2,038	1,095	383	299
2009	1,982	1,505	377	329
2010	2,047	1,820	349	394
2011	2,033	1,937	292	429
2012	2,058	2,516	258	467
2013	1,821	2,418	238	434
2014	1,799	2,745	212	497
2015	1,698	3,049	184	484
2016	1,566	3,340	163	440
2017	1,476	3,526	142	463
2018	1,314	3,670	97	444
2019	1,297	3,940	95	422
2020	675	2,108	68	282
2021	829	2,725	55	283
Total	27,911	37,706	5,048	6,132

Tables 3.K17 (a) and (b) above show that the numbers of revisions and the relative proportion of revisions with an associated primary in the registry increased with time. Over 77% of those revisions performed in 2021 had a linked primary in the registry. We propose that this is likely to reflect improved data capture over time, improved linkability of records and the longevity of knee replacements, with a proportion of primaries being revised having been performed before registry data capture began or are outside the coverage of the registry.

3.3.9 90-day mortality after knee revision

The overall cumulative percentage probability of mortality at 90 days after knee revision was lower in the cases with their primaries documented in the registry compared with the remainder (Kaplan-Meier estimates 0.79% (95% CI 0.71-0.88) versus 1.05% (95% CI 0.94-1.16)), which may reflect the fact that this patient group was younger at the time of their first revision, with a median age of 68 (IQR 61 to 75) years, compared to the group without primaries documented in the registry who had a median age of 73 (IQR 65 to 79) years. The percentage of males was similar in both groups (45.1% versus 46.8% respectively).

3.3.10 Conclusions

There are now over 1.4 million primary knee replacements recorded in the registry with a maximum follow-up of 18.75 years, making this the largest dataset of its kind in the world. Of these, 96.6% of the procedures were performed for osteoarthritis as the only indication. Approximately 90% of the procedures are TKRs, 9% medial or lateral unicondylar knee replacements and 1% patellofemoral replacements. These overall proportions have remained relatively constant over time but the annual proportion of unicondylar knee replacements has risen since 2013, reaching approximately 10% for the first time in 2017 and rising to 13.4% in 2021. The popularity of uncemented unicondylar replacements has risen relatively rapidly. These made up less than 1% of knee replacements in 2010 and now account for 5.1%, that is over a third of the unicondylar knee replacements performed. This increase in the proportion of primary knee procedures that are unicondylar knee replacements is supported by recent guidance from NICE published in 2020 and Quality Standards published by NICE in 2022 (NICE,2020; NICE,2022). Cemented, unconstrained (cruciate retaining), fixed bearing TKR remains by far the most common type of knee replacement, followed by cemented, posterior stabilised, fixed bearing TKR. Patients who received unicondylar or patellofemoral knee replacement were typically younger than those receiving a TKR. Both TKR and patellofemoral replacement are more likely to be performed on females, whereas unicondylar knee replacement is more likely to be performed on males.

TKRs with a monobloc polyethylene tibia consistently show some of the lowest crude revision rates, although the numbers at risk beyond 15 years are small, so must be interpreted with caution. Cemented TKRs that are unconstrained with a fixed bearing, as well as being the most common type of TKR, consistently show low revision rates in comparison to alternatives; crude revision rates are approximately one percentage point lower in comparison to cemented unconstrained TKRs with a mobile bearing and cemented TKRs that are posterior stabilised, with either a fixed or mobile bearing at 15 years.

Age and gender influence the risk of revision surgery. Younger patients and males are more likely to undergo revision and it has previously been felt that this may explain the higher revision rates observed in UKR. We present results divided by gender and age group and these show the risk of revision of a cemented unicondylar knee replacement is at least two times higher in males and 2.4 times higher in females at ten years than a cemented TKR. The distinction of uncemented unicondylar knee replacements shows that revision rates are lower than for cemented unicondylar replacements but remain higher than for cemented TKR. The risk of revision of a patellofemoral replacement is at least 2.9 times higher in both males and females than a cemented TKR across all age groups at ten years and the results of multicompartmental knee replacements show similarly high revision rates.

The most common causes of revision across all primary knee replacements were for aseptic loosening / lysis, infection and progressive arthritis. For uncemented TKRs, the incidence of revision for infection was lower than for cemented TKR but higher for nearly all other indications. For cemented unicondylar knee replacements, the highest risk of revision was for progressive arthritis, aseptic loosening / lysis and pain. For uncemented unicondylar knee replacements, the third most common indication was dislocation / subluxation rather than pain. The incidence of revision for indications such as pain and aseptic loosening / lysis was lower for uncemented unicondylar than for cemented, but higher for dislocation / subluxation and periprosthetic fractures. Progression of osteoarthritis elsewhere in the knee is also the fourth most common indication selected by surgeons for revision knee replacement. The risk of revision for progressive arthritis, aseptic loosening / lysis and pain were all higher for UKRs than TKRs, but the risk of revision for infection was lower.

Infection accounts for the majority of the two-stage revision procedures performed. Approximately 8% of revisions for infection that have been recorded in the registry to date have been single-stage procedures. At this time, the single-stage group includes DAIR

https://www.nice.org.uk/guidance/ng157/chapter/Recommendations#procedures-for-primary-elective-knee-replacement
https://www.nice.org.uk/guidance/qs206/chapter/Statement-2-Choice-between-partial-and-total-knee-replacement

procedures so this indicates low usage and take-up of single-stage revision in the treatment of knee prosthetic joint infection. The soft tissue envelope makes single-stage knee revision surgery potentially more challenging than that in the hip, which may explain the differences in utilisation of a single-stage approach.

The risk of re-revision following a revision procedure is higher than the risk of revision of a primary TKR across all types of knee replacement. The risk of re-revision of a revised patellofemoral replacement is slightly lower than the other types of knee, with the rest being broadly similar. This suggests that caution should be exercised when proposing that a UKR may be considered as an interim procedure or a lesser intervention than a TKR, as the crude re-revision rates are worse than the revision rates for primary TKR, and are broadly similar regardless of the type of the knee replacement implanted at the primary procedure. The risk of re-revision is higher for those revised after a shorter period of time following the primary and is associated with the specific indication for revision. This suggests that not all of the processes that lead to revision are the same and that some have greater impact than others with consequences beyond the initial revision.

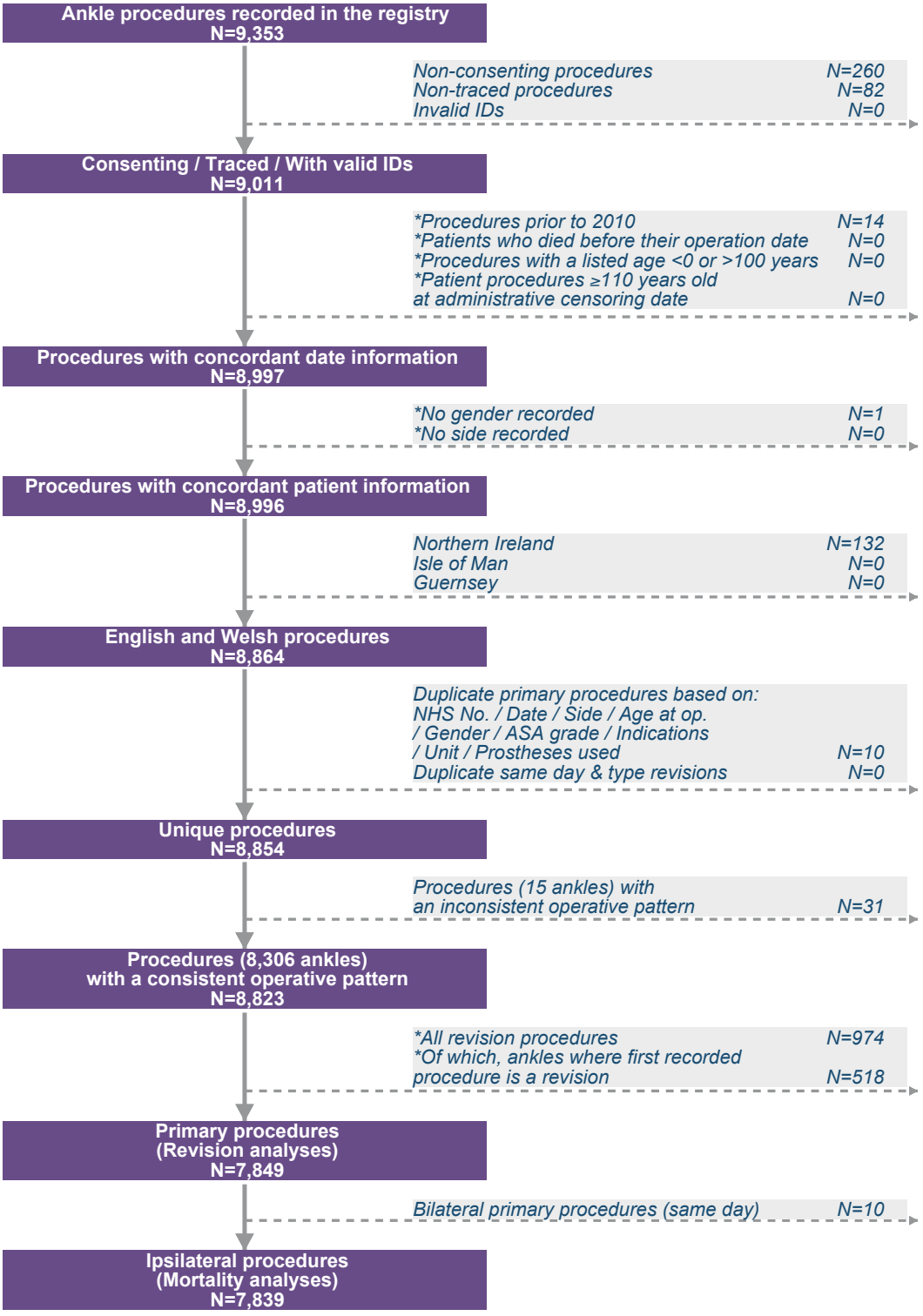
Knee replacement remains a safe procedure with low rates of peri-operative mortality. The rates of mortality are higher for males than those for females. The average age of a patient undergoing a TKR is approximately 70 years; approximately 57% of males and 46% of females in the 70 to 74 age bracket will have died within 15 years of their knee replacement. This means that for the average patient undergoing a knee replacement, their knee replacement should last them for the rest of their life, without the need for revision surgery.

3.4 Outcomes after ankle replacement

3.4.1 Overview of primary ankle replacement surgery

In this section of the report, we look at revision and mortality for all primary ankle operations submitted to the registry from 1 January 2010 up to 31 December 2021. There were, after data cleaning, 7,849 primary ankle operations available for analysis on 7,455 patients. A total of 394 patients had bilateral operations (ten had both sides operated on the same date), which can be seen in the patient flow diagram in Figure 3.A1 (page 213).

Figure 3.A1 Ankle cohort flow diagram.



** Reasons not necessarily mutually exclusive*

The median age at primary surgery was 69 years (IQR 62 to 75 years), with an overall range of 17 to 97 years. More procedures were performed in males (59.9%) than in females.

All ankle replacement brands recorded in the registry are uncemented implants, but cement can be used occasionally by surgeons in circumstances such as poor bone stock or low demand patients. Of the 7,849 primary procedures, a total of 7,513 (95.7%) procedures were implanted without cement being listed in the component data. Cement was listed in 336 (4.3%) of primary procedures. Of all total ankle replacement (TAR) procedures, 189 (2.4%) were defined as unconfirmed. Procedures were defined as unconfirmed when they either had insufficient elements to form a coherent construct or they contained custom-made prostheses.

Figure 3.A2 illustrates the temporal changes in fixation of primary ankle replacements.

Figure 3.A2 Fixation by year of primary ankle replacement.

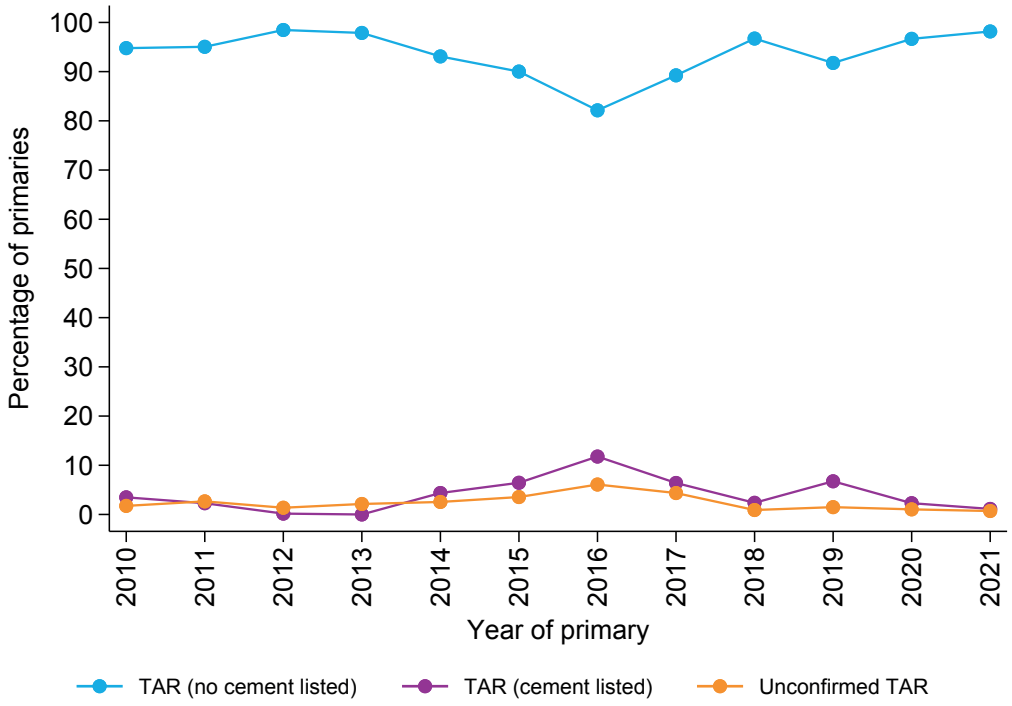


Figure 3.A3 and Figure 3.A4 (page 216) show the yearly number of primary ankle replacements performed for all indications and ankle replacements stratified by fixed and mobile bearings. Please note the difference in scale of the y-axis between each plot. Each bar in the figure is further stratified by the volume of procedures that the surgeon conducted in that year, and when procedures are stratified by fixed and mobile bearings, the volume of procedures is calculated separately. For example, if a surgeon performed 25 primary ankle replacements procedures, their procedures would have contributed to the grey sub-division in Figure 3.A3; if those procedures consisted of 12 fixed bearings and 13 mobile bearings those procedures would be represented by green and purple bars respectively in Figure 3.A4.

Figure 3.A3 shows the volume of primary ankle replacements recorded in the registry increasing since 2015. In 2020 and 2021 the number of primary ankle replacements added were lower than previous years due to the impact of COVID-19. The majority of additional procedures were contributed to the registry by higher volume ankle surgeons i.e. surgeons who perform more than 13 TAR procedures annually. Figure 3.A4 illustrates that the expansion of TAR procedures has largely been of a fixed bearing design and that the use of mobile bearing has steadily been decreasing. Many of the changes in bearing use are due to the voluntary withdrawal of the Mobility in 2014 and the introduction of the INFINITY in the same year.

Figure 3.A3 Frequency of primary ankle replacements, bars stacked by volume per consultant per year.

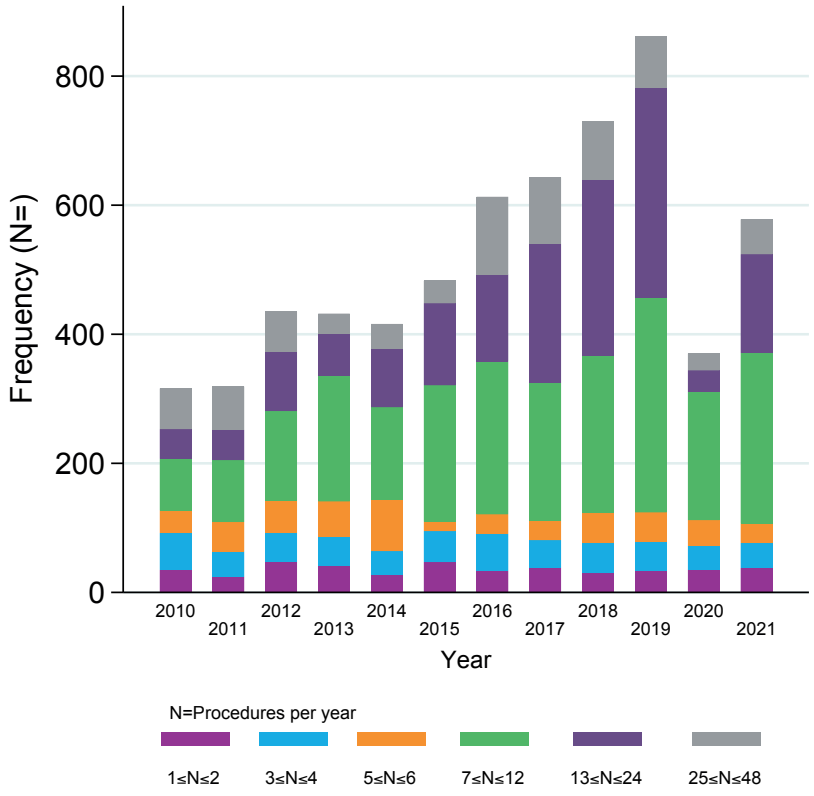


Figure 3.A4 Frequency of primary ankle replacements stratified by fixed and mobile bearings, bars stacked by volume per consultant per year.

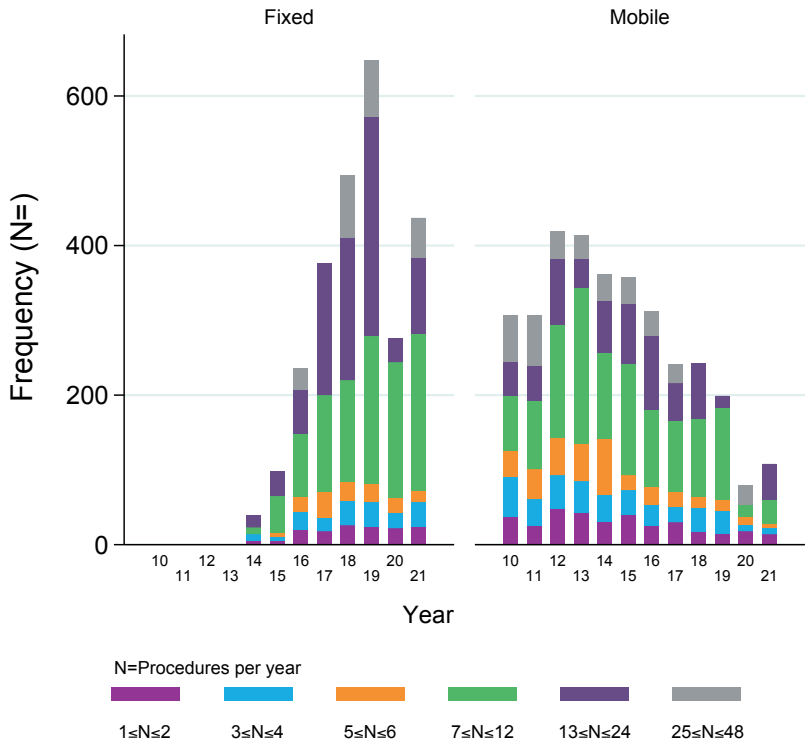


Table 3.A1 Descriptive statistics of ankle procedures performed by consultant and unit by year of surgery.

Number of primary replacements during each year	Year of surgery											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Number of procedures in year	402	525	585	562	550	621	739	781	886	1008	480	710
Units (N)	104	127	145	134	139	143	144	146	150	161	129	141
Mean number of primary replacements per unit	3.9	4.1	4.0	4.2	4.0	4.3	5.1	5.3	5.9	6.3	3.7	5.0
Median (IQR) number of any primary replacements per unit	2 (1 to 4)	2 (1 to 5)	2 (1 to 5)	2 (1 to 5)	2 (1 to 4)	2 (1 to 5)	2 (1 to 6.5)	3 (1 to 6)	3 (1 to 7)	3 (2 to 8)	2 (1 to 5)	3 (2 to 7)
Units who entered ≥10 operations (N)	10	9	13	12	11	10	20	18	24	31	9	17
Units who entered ≥20 operations (N)	3	3	4	4	4	6	7	6	8	6	2	5
Consultants providing operation (N)	107	126	143	133	126	142	137	141	148	156	119	135
Mean number of primary replacements per consultant	3.8	4.2	4.1	4.2	4.4	4.4	5.4	5.5	6.0	6.5	4.0	5.3
Median (IQR) number of any primary replacements per consultant	2 (1 to 4)	3 (2 to 5)	2 (1 to 5)	3 (1 to 5)	3 (2 to 5)	2 (1 to 6)	3 (2 to 8)	3 (1 to 8)	4 (2 to 8)	5 (2 to 9)	3 (1 to 5)	3 (1 to 8)
Consultants who entered ≥10 operations (N)	10	10	12	13	10	16	21	28	32	36	9	24
Consultants who entered ≥20 operations (N)	2	3	2	2	2	4	5	7	6	5	1	4

Table 3.A1 shows a trend of an increasing number of annually reported cases over the 11-year observation period, other than the COVID-19 impacted years of 2020 and 2021. This could represent improved compliance or the reporting of a true increase in caseload prior to COVID-19.

A total of 300 consultants carried out the 7,849 reported primary procedures over the 11-year period. The annual mean number of procedures per consultant was 3.8 in 2010, and principally due to COVID-19, was 5.3 in 2021. Only 3.0% of consultants performed 20 or more primary ankle replacements in 2021 and a further 14.8% performed between 10 and 19 primary ankle replacements. Of the 283 units who submitted data to the registry, 11 (3.9%) carried out 20 or more procedures since the start of the data collection. The percentage of units submitting 20 or more ankle primary operations each year does not exceed 5% (2018) (3.5% in 2021). The number of units submitting more than 20 primary ankle procedures per year increased from three in 2010 to a peak of eight in 2018 and was five in 2021. The mean number of primary replacements per unit increased from 3.9 in 2010 to a peak of 6.3 in 2019 and was 5.0 in 2021.

Table 3.A2 Number and percentage of primary ankle replacements by ankle brand.

Brand	Number of primaries (%)	Number (%) of each brand, for each year of operation											
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Akile	45 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (0.6)	9 (1.2)	12 (1.5)	11 (1.2)	8 (0.8)	<4 (0.2)	0 (0.0)
Box	799 (10.2)	22 (5.5)	27 (5.1)	45 (7.7)	51 (9.1)	81 (14.7)	134 (21.6)	126 (17.1)	109 (14.0)	103 (11.6)	80 (7.9)	21 (4.4)	0 (0.0)
CCI	<4 (0.0)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Cadence	81 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.4)	6 (0.8)	15 (1.7)	23 (2.3)	11 (2.3)	23 (3.2)
Cremascoli[Talar] [Tibial]	<4 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.1)
FAR	<4 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.1)
Hintegra	296 (3.8)	9 (2.2)	17 (3.2)	35 (6.0)	67 (11.9)	47 (8.5)	54 (8.7)	33 (4.5)	9 (1.2)	14 (1.6)	11 (1.1)	0 (0.0)	0 (0.0)
INBONE	159 (2.0)	0 (0.0)	0 (0.0)	<4 (0.3)	4 (0.7)	16 (2.9)	<4 (0.5)	25 (3.4)	25 (3.2)	27 (3.0)	18 (1.8)	11 (2.3)	28 (3.9)
INBONE[Talar] INFINITY[Tibial]	255 (3.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.9)	16 (2.6)	30 (4.1)	31 (4.0)	35 (4.0)	52 (5.2)	34 (7.1)	52 (7.3)
INFINITY	2,602 (33.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	28 (5.1)	95 (15.3)	213 (28.8)	378 (48.4)	489 (55.2)	623 (61.8)	312 (65.0)	464 (65.4)
INFINITY[Talar] INBONE[Tibial]	<4 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.1)	<4 (0.2)	0 (0.0)	0 (0.0)
Mobility	1,125 (14.3)	252 (62.7)	297 (56.6)	286 (48.9)	204 (36.3)	86 (15.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Rebalance	63 (0.8)	0 (0.0)	4 (0.8)	14 (2.4)	13 (2.3)	7 (1.3)	4 (0.6)	13 (1.8)	7 (0.9)	<4 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
Salto	327 (4.2)	22 (5.5)	29 (5.5)	40 (6.8)	45 (8.0)	55 (10.0)	55 (8.9)	44 (6.0)	9 (1.2)	11 (1.2)	11 (1.1)	4 (0.8)	<4 (0.3)
STAR	709 (9.0)	14 (3.5)	28 (5.3)	30 (5.1)	34 (6.0)	59 (10.7)	74 (11.9)	84 (11.4)	100 (12.8)	95 (10.7)	88 (8.7)	53 (11.0)	50 (7.0)
Trabecular Metal Total	6 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.7)	0 (0.0)	<4 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
Vantage	71 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	17 (1.7)	4 (0.8)	50 (7.0)
Zenith	1,116 (14.2)	76 (18.9)	109 (20.8)	124 (21.2)	132 (23.5)	152 (27.6)	160 (25.8)	109 (14.7)	61 (7.8)	75 (8.5)	60 (6.0)	24 (5.0)	34 (4.8)
Unconfirmed	**189 (2.4)**	**7 (1.7)**	**14 (2.7)**	**8 (1.4)**	**12 (2.1)**	**14 (2.5)**	**22 (3.5)**	**45 (6.1)**	**34 (4.4)**	**8 (0.9)**	**15 (1.5)**	**5 (1.0)**	**5 (0.7)**
Total	**7,849 (100)**	**402 (100)**	**525 (100)**	**585 (100)**	**562 (100)**	**550 (100)**	**621 (100)**	**739 (100)**	**781 (100)**	**886 (100)**	**1008 (100)**	**480 (100)**	**710 (100)**

Table 3.A2 (page 218) shows the number of replacements by implant brand and year of primary operation. The most frequently used brand is the fixed bearing INFINITY[Tal:Tib] (Stryker), which represented 65.4% of primary ankle replacements performed in 2021. The use of this brand has risen steeply from its introduction in 2014.

We are identifying when components, within primary ankle replacements, come from different brands and/or manufacturers. There are no examples of mix and match between manufacturers within ankle replacements. The INFINITY and INBONE implants, both now manufactured by Stryker, were designed to be interchangeable with a similar articulating surface. This combination represented 7.3% of primary ankle replacements in 2021. Prior to the introduction of the INFINITY, the Mobility (DePuy) had been the market leader before it was voluntarily withdrawn.

In 2021, the three most common brands were INFINITY[Tal:Tib] (65.4%), INBONE[Tal]INFINITY Tibial[Tib] (7.3%) and STAR[Tal:Tib] (7.0%). As defined in Table 3.A2, it was not possible to identify the type of constructs implanted in five procedures (0.7%) in 2021.

3.4.2 Revisions after primary ankle replacement surgery

A total of 396 out of the 7,849 primary procedures had a linkable A2 MDS form completed to indicate a revision before the end of 2021. The first revisions shown here include 49 conversions to arthrodesis, 271 single-stage procedures, 63 two-stage procedures, 13 DAIRs, ten with modular exchange and three without. No amputations have been recorded, and, given the low rate reported for conversion to arthrodesis, we believe that these small numbers might reflect under-reporting.

Table 3.A3 KM estimates of cumulative revision (95% CI) of primary ankle replacement, by gender and age.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Age at primary (years)	Number of primaries	Time since primary					
		1 year	3 years	5 years	7 years	10 years	11 years
All cases	7,849	0.77 (0.60-1.00)	3.16 (2.76-3.61)	5.56 (4.98-6.20)	7.22 (6.50-8.02)	9.01 (8.04-10.08)	9.19 (8.17-10.33)
Female	3,150	0.78 (0.52-1.16)	3.54 (2.90-4.32)	6.28 (5.34-7.37)	7.99 (6.83-9.33)	10.12 (8.53-11.98)	*10.50 (8.78-12.53)*
<65	1,156	0.83 (0.43-1.59)	5.13 (3.92-6.70)	9.44 (7.64-11.63)	11.89 (9.72-14.50)	*14.90 (11.95-18.49)*	*14.90 (11.95-18.49)*
65 to 74	1,224	0.78 (0.41-1.49)	3.24 (2.33-4.52)	5.50 (4.19-7.22)	7.32 (5.62-9.52)	*9.20 (6.98-12.07)*	*9.20 (6.98-12.07)*
≥75	770	0.68 (0.28-1.63)	1.52 (0.81-2.82)	2.24 (1.28-3.90)	*2.24 (1.28-3.90)*	*2.74 (1.53-4.89)*	*5.01 (1.96-12.47)*
Male	4,699	0.77 (0.55-1.08)	2.89 (2.41-3.46)	5.06 (4.36-5.88)	6.69 (5.80-7.72)	8.17 (7.04-9.47)	*8.17 (7.04-9.47)*
<65	1,487	0.94 (0.55-1.61)	4.23 (3.26-5.50)	6.86 (5.49-8.54)	8.55 (6.90-10.56)	*9.72 (7.80-12.08)*	*9.72 (7.80-12.08)*
65 to 74	1,958	0.70 (0.41-1.20)	2.64 (1.98-3.53)	5.05 (4.00-6.36)	7.27 (5.86-9.00)	*9.42 (7.59-11.66)*	*9.42 (7.59-11.66)*
≥75	1,254	0.67 (0.34-1.34)	1.61 (1.00-2.59)	2.67 (1.77-4.03)	3.02 (1.97-4.61)	*3.40 (2.20-5.25)*	*3.40 (2.20-5.25)*

Note: Arthrodesis and amputation revision procedures may be under-reported in the registry.

Figure 3.A5 KM estimates of cumulative revision of primary ankle replacement (shaded area indicates point-wise 95% CI).

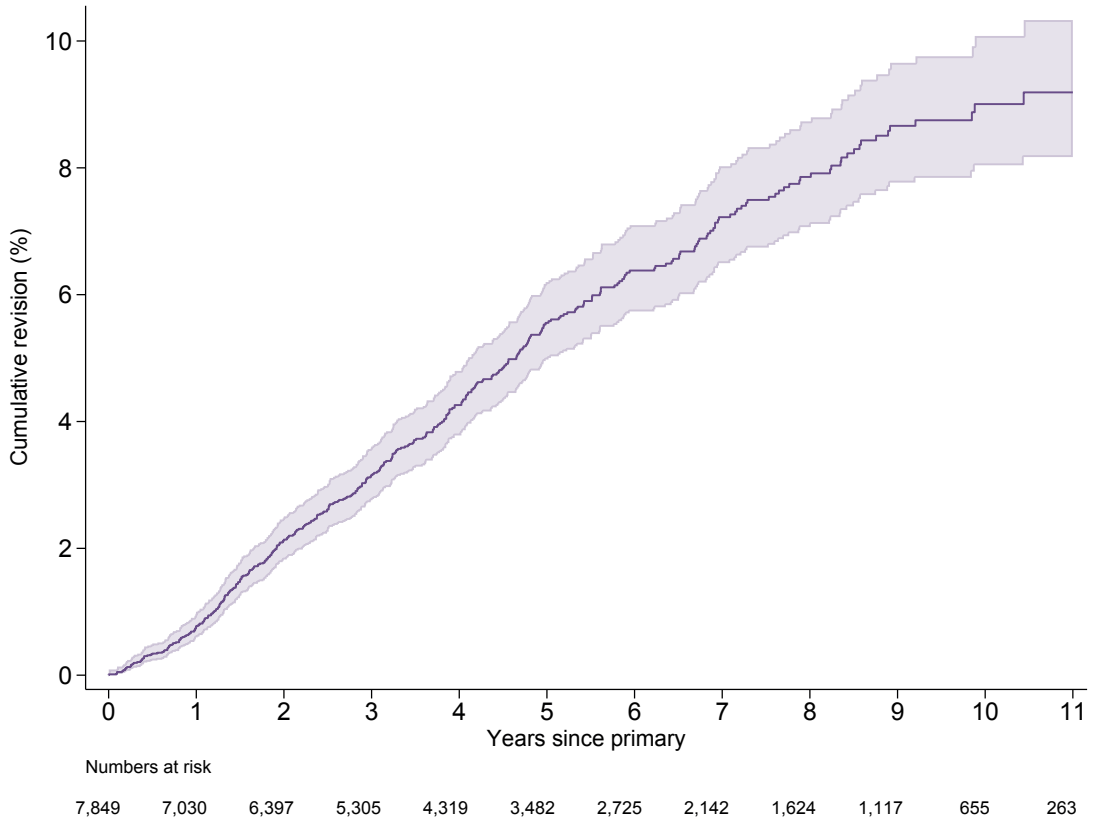


Figure 3.A5 and Table 3.A3 (page 219) show the overall estimated cumulative percentage probability of (first) revision. Results are also stratified by gender and age.

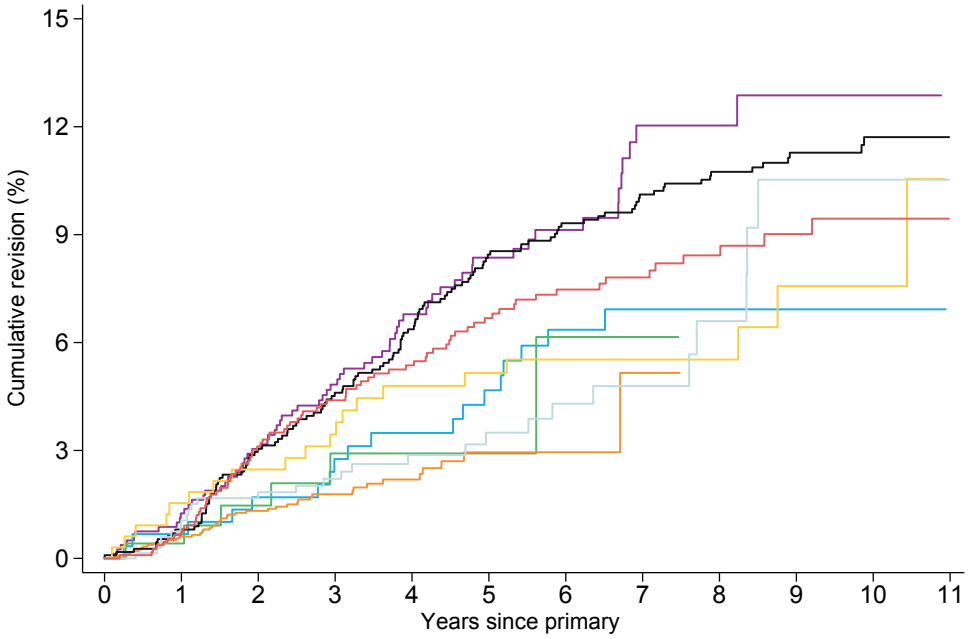
Table 3.A4 (page 221) and Figure 3.A6 (page 222) show the estimated cumulative percentage probability of (first) revision by implant brand with at least 250 uses. Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time-period. At one year post-operation rates of revision were heterogeneous between brands, varying from 0.41% (95% CI 0.06-2.91) to 1.54% (95% CI 0.64-3.65). Larger variations between brands were observed for later post-operative periods, with rates varying from 2.92% (95% CI 1.19-7.05) to 8.45% (95% CI 6.94-10.26) at five years post-operation. The large relative differences between the lowest and highest rates seem to be related to the implant brand and are unlikely to be entirely due to patient age and gender case mix. At ten years post-operation, the 95% Confidence Intervals are large, overlapping each other, and no robust comparison between brands can be performed until the size of the cohort becomes larger.

Table 3.A4 KM estimates of cumulative revision (95% CI) of primary ankle replacement, by brand. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand	Number of primaries	Age median (IQR)	Male (%)	Time since primary					
				1 year	3 years	5 years	7 years	10 years	11 years
Box	799	67 (60-73)	65	1.25 (0.68-2.31)	4.83 (3.52-6.61)	8.36 (6.48-10.75)	*12.03 (9.31-15.48)*	*12.87 (9.83-16.77)*	*12.87 (9.83-16.77)*
Hintegra	296	70 (63-75)	66	0.68 (0.17-2.67)	2.76 (1.39-5.45)	*4.67 (2.74-7.92)*	*6.92 (4.39-10.83)*	*6.92 (4.39-10.83)*	
INBONE[Talar] INFINITY[Tibial]	255	68 (59-74)	49	*0.41 (0.06-2.91)*	*2.92 (1.19-7.05)*	*2.92 (1.19-7.05)*			
INFINITY	2,602	69 (62-75)	60	0.60 (0.36-1.02)	1.78 (1.28-2.49)	2.95 (2.08-4.19)	*5.16 (2.18-11.92)*		
Mobility	1,125	68 (61-75)	55	0.80 (0.42-1.54)	4.61 (3.52-6.02)	8.45 (6.94-10.26)	10.12 (8.46-12.08)	11.71 (9.86-13.88)	*11.71 (9.86-13.88)*
Salto	327	69 (62-74)	59	1.54 (0.64-3.65)	3.45 (1.92-6.14)	5.15 (3.19-8.28)	*5.53 (3.47-8.75)*	*7.57 (4.58-12.38)*	*10.55 (5.48-19.80)*
STAR	709	69 (63-76)	64	1.05 (0.50-2.20)	2.21 (1.31-3.71)	3.50 (2.20-5.53)	*4.79 (3.05-7.49)*	*10.53 (6.29-17.35)*	
Zenith	1,116	69 (63-75)	58	0.74 (0.37-1.47)	4.40 (3.31-5.83)	6.68 (5.28-8.44)	7.81 (6.25-9.74)	*9.44 (7.49-11.88)*	*9.44 (7.49-11.88)*

Note: Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time period.
Note: Brands with less than 250 procedures are not reported.
Note: Arthrodesis and amputation revision procedures may be under-reported in the registry.

Figure 3.A6 KM estimates of cumulative revision of primary ankle replacement by brand. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk											
Zenith	1,116	1,065	1,004	918	821	739	620	480	343	*230*	*134*	*57*
STAR	709	646	586	494	394	293	*216*	*145*	*90*	*57*	*31*	*7*
Salto	327	319	306	289	270	256	*215*	*165*	*113*	*70*	*42*	*15*
Mobility	1,125	1,108	1,072	1,038	1,000	961	926	893	797	608	375	*156*
INFINITY	2,602	2,104	1,762	1,152	666	300	*105*	*24*				
INBONE[Talar]INFINITY[Tibial]	255	*200*	*165*	*113*	*81*	*50*	*18*	*5*				
Hintegra	296	292	288	273	252	*235*	*193*	*145*	*96*	*41*	*15*	*5*
Box	799	788	743	646	523	416	296	*180*	*116*	*72*	*40*	*18*

Table 3.A5 Indications for the first revisions following primary ankle replacement.
Note: These are not mutually exclusive.

Indication	Total number revised	Number of revisions per 100 prosthesis-years (95% CI)
Infection	**113**	**0.29 (0.24-0.35)**
Aseptic loosening	**182**	**0.47 (0.40-0.54)**
Aseptic loosening of tibial component only	45	0.12 (0.09-0.15)
Aseptic loosening of talar component only	58	0.15 (0.12-0.19)
Aseptic loosening of both tibial and talar components	79	0.20 (0.16-0.25)
Lysis	**81**	**0.21 (0.17-0.26)**
Lysis of tibial component only	18	0.05 (0.03-0.07)
Lysis of talar component only	31	0.08 (0.06-0.11)
Lysis of both tibial and talar components	32	0.08 (0.06-0.12)
Malalignment	**74**	**0.19 (0.15-0.24)**
Implant fracture	**18**	**0.05 (0.03-0.07)**
Implant fracture of tibial component only	0	. (.-.)
Implant fracture of talar component only	<4	0.01 (0.00-0.02)
Implant fracture of meniscal component only	14	0.04 (0.02-0.06)
Implant fracture of tibial and talar components	<4	0.01 (0.00-0.02)
Meniscal insert dislocation	**11**	**0.03 (0.02-0.05)**
Wear of polyethylene component	**40**	**0.10 (0.08-0.14)**
Component migration/dissociation	**27**	**0.07 (0.05-0.10)**
Pain	**82**	**0.21 (0.17-0.26)**
Stiffness	**46**	**0.12 (0.09-0.16)**
Soft tissue impingement	**37**	**0.10 (0.07-0.13)**
Other indication for revision	**44**	**0.11 (0.08-0.15)**

Note: Four revision procedures recorded no reason for the revision and were removed from the analysis.
Note: In MDSv4 pain was referred to as Pain (undiagnosed) and in MDSv6 onwards pain was referred to as Unexplained Pain.

Table 3.A5 shows the indications for revision of ankle replacements, with aseptic loosening and infection as the most commonly cited indications.

Of the revisions for infection, 28 (24.8%) were recorded as having a high suspicion of infection (e.g. pus or confirmed micro) and the remaining revisions for infection (75.2%) had a low suspicion (awaiting micro/histo). Out of the 182 revisions for aseptic loosening, 43.4% were performed because of loosening of both the tibial and talar components.

Of patients revised for an indication of lysis, 39.5% had lysis of both tibial and talar components. Of the 18 revisions for implant fracture, 14 (77.8%) were performed for a fractured meniscal insert.

There is concern that there may be under-reporting of revisions of ankle replacement, in particular when the revision is to an ankle arthrodesis or amputation.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip,

knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint.

For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

3.4.3 Mortality after primary ankle replacement surgery

In this analysis, the second of each of the ten (same day) bilateral procedures were excluded. Among the remaining 7,839, a total of 719 patients had died before the end of 2021, 246 of these were female and 473 were male.

Figure 3.A7 KM estimates of cumulative mortality after primary ankle replacement (shaded area indicates point-wise 95% CI).

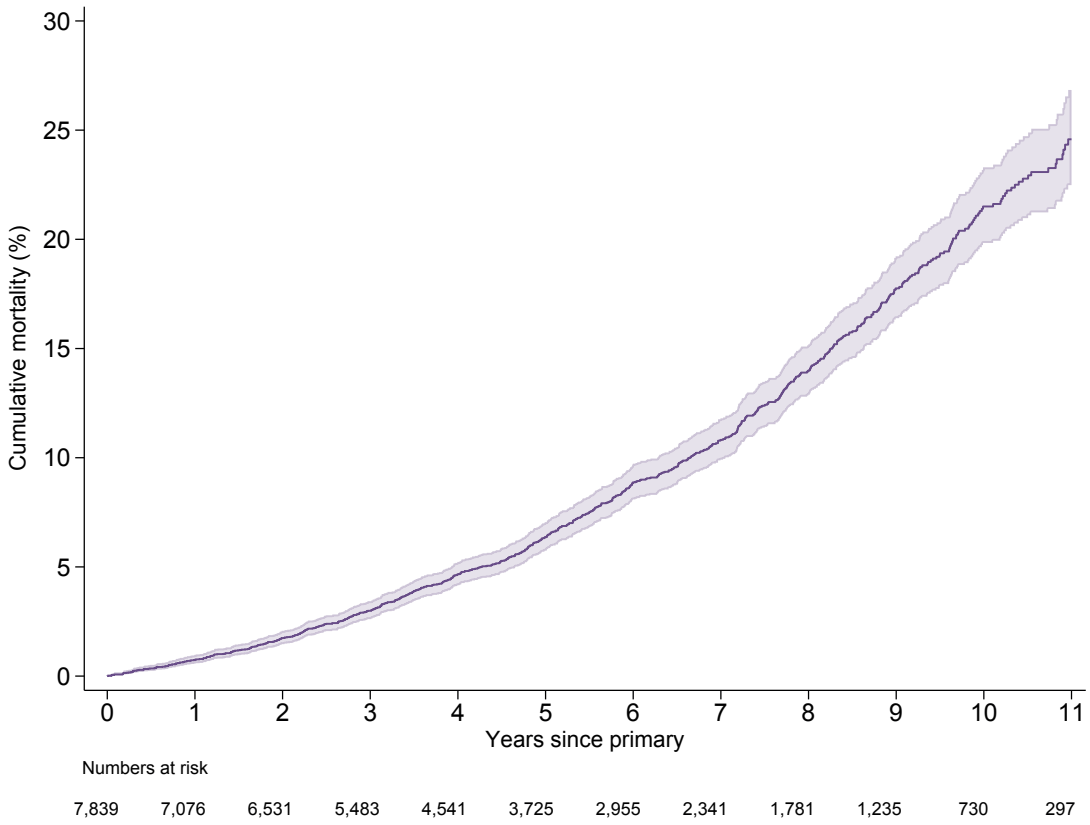


Table 3.A6 KM estimates of cumulative mortality (95% CI) after primary ankle replacement, by gender and age. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Age at primary (years)	Number of primaries	Time since primary							
		30 days	90 days	1 year	3 years	5 years	7 years	10 years	11 years
All cases	7,839	0.08 (0.03-0.17)	0.17 (0.10-0.29)	0.75 (0.58-0.98)	2.99 (2.61-3.43)	6.36 (5.74-7.05)	10.82 (9.91-11.80)	21.51 (19.83-23.30)	24.58 (22.48-26.84)
Female	3,148	0.03 (0.00-0.23)	0.13 (0.05-0.34)	0.61 (0.38-0.96)	2.41 (1.90-3.07)	4.99 (4.15-5.98)	9.08 (7.80-10.56)	17.86 (15.58-20.43)	*21.57 (18.42-25.17)*
<65	1,154	0	0.18 (0.04-0.70)	0.36 (0.14-0.96)	1.38 (0.82-2.33)	2.67 (1.77-4.03)	5.27 (3.76-7.36)	*8.07 (5.96-10.89)*	*9.35 (6.44-13.47)*
65 to 74	1,224	0.08 (0.01-0.58)	0.16 (0.04-0.66)	0.60 (0.29-1.25)	1.96 (1.28-2.99)	3.99 (2.87-5.53)	7.25 (5.51-9.52)	*15.80 (12.41-20.00)*	*18.20 (13.83-23.75)*
≥75	770	0	0	0.99 (0.47-2.07)	4.78 (3.36-6.79)	10.46 (8.08-13.50)	*18.69 (15.09-23.02)*	*38.25 (31.79-45.52)*	*49.45 (39.35-60.57)*
Male	4,691	0.11 (0.04-0.26)	0.19 (0.10-0.37)	0.85 (0.62-1.17)	3.38 (2.86-3.99)	7.30 (6.45-8.25)	12.01 (10.79-13.35)	24.19 (21.86-26.72)	*26.81 (24.08-29.80)*
<65	1,486	0	0	0.07 (0.01-0.49)	1.33 (0.83-2.14)	2.88 (2.03-4.07)	3.79 (2.71-5.30)	*7.91 (5.63-11.07)*	*10.49 (7.19-15.19)*
65 to 74	1,954	0.15 (0.05-0.48)	0.21 (0.08-0.55)	0.86 (0.53-1.40)	2.95 (2.24-3.88)	6.47 (5.28-7.92)	10.19 (8.53-12.16)	*19.74 (16.69-23.26)*	*22.41 (18.77-26.64)*
≥75	1,251	0.16 (0.04-0.64)	0.41 (0.17-0.97)	1.78 (1.16-2.71)	6.58 (5.23-8.27)	14.30 (12.05-16.92)	25.66 (22.33-29.39)	*55.07 (48.48-61.91)*	*57.83 (50.58-65.27)*

Note: Some patients had operations on the left and right side on the same day. The second of bilateral operations performed on the same day were excluded.

Figure 3.A7 and Table 3.A6 (pages 224 and 225) show the estimated cumulative percentage probability of death at different times after surgery, by gender and age at primary. Male patients and patients of older age were more likely to have died.

3.4.4 Conclusions

Compared to the other joint types included in the annual report, primary ankle replacement is a low volume procedure, and linked first revisions are even lower. It is likely that there is significant under-reporting of revision to arthrodesis procedures, or revision to amputation, making outcome analysis interpretation only preliminary in nature.

Since the withdrawal of the Mobility implant in 2014, the fixed bearing INFINITY implant has rapidly gained popularity to become the market leader and survivorship data is encouraging at present.

Although there has been a trend towards an increasing volume of replacements by unit, the mean number per unit has only risen from 3.9 to 6.2 per year between 2010 to 2019, with an expected fall off in numbers in 2020 and 2021 due to COVID-19.

Only 12.1% of units conducting ankle replacements performed more than ten per year in 2021 and, in the same year, just 3.5% of units performed more than 20 primary procedures. The British Orthopaedic Foot and Ankle Society (BOFAS) encourages surgeons to pool resources and create networks, where practicable, to ensure the sharing of best practice in the achievement of the highest standards of care and outcome quality for patients.

The cumulative percentage probability of 90-day mortality following primary ankle surgery is very low (0.17% (95% CI 0.10-0.29)) and the cumulative percentage of revision at ten years following a primary ankle replacement is 9.01% (95% CI 8.04-10.08). Substantial heterogeneity in the rates of revision was observed between the implant brands used in primary ankle replacement surgery.

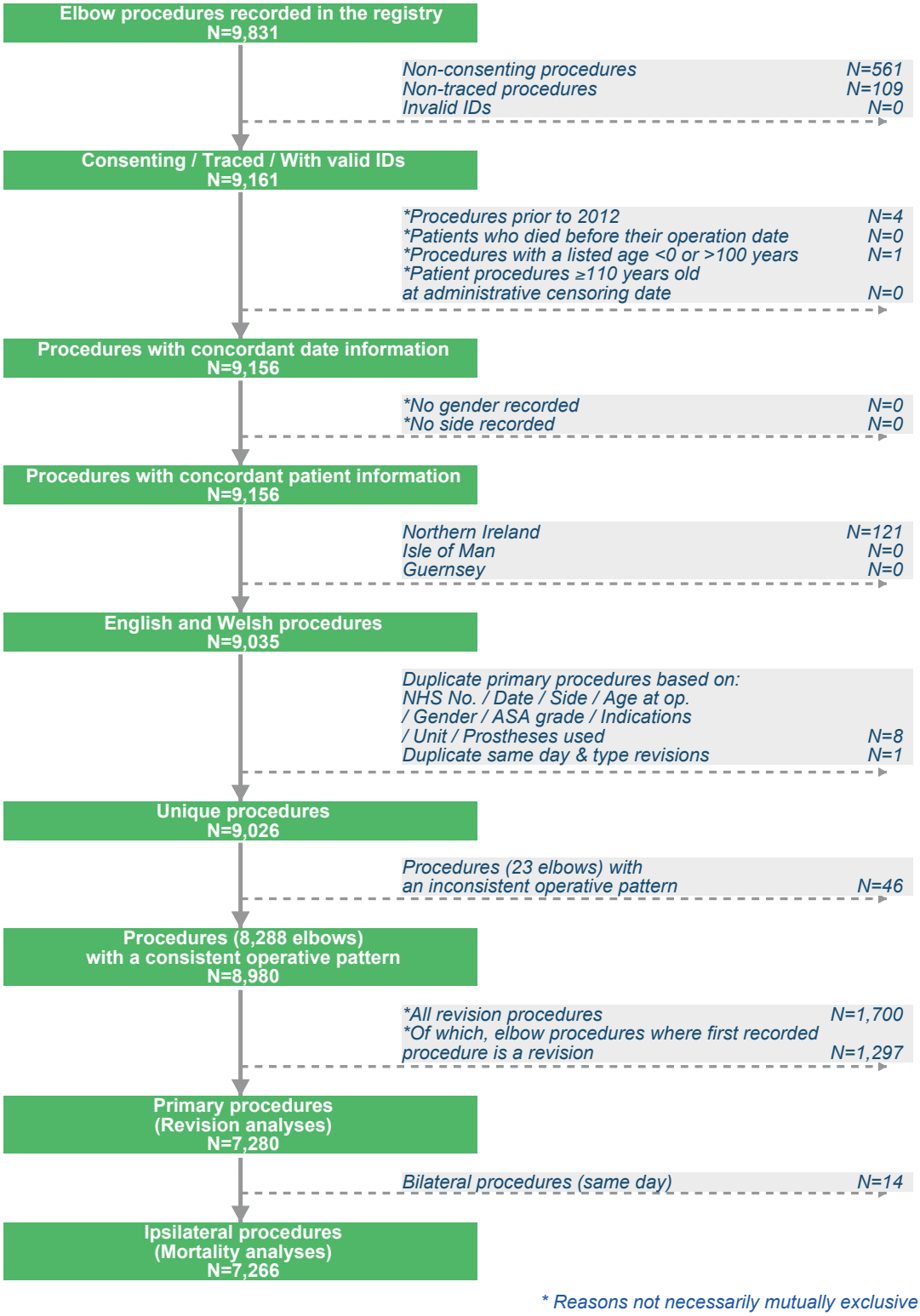
3.5 Outcomes after elbow replacement

3.5.1 Overview of primary elbow replacement surgery

In this section we detail the primary elbow replacements entered into the registry since recording began (1 April 2012) up to the end of 31 December 2021. Data on linked first revision episodes and linked mortality data are presented. Primary elbow replacement in this section refers to total replacement (with or without radial head replacement), distal humeral hemiarthroplasty, lateral resurfacing, and radial head replacement. We conducted an extended review of the component labels reported on the primary elbow (E1) MDS form. Our analysis has been able to identify total replacements with a radial head replacement (n=67) and investigate inconsistencies between the type of procedure reported on the MDS form and the component label data uploaded to the registry. Procedures where the reported type of surgery did not match the components listed on the MDS form are classified as unconfirmed in the elbow section of the report.

During 2021-2022 the NJR Data Quality Committee has overseen an audit exercise of the elbow replacement dataset with matching to Hospital Episode Statistics (HES) to identify missing data and source checking for mismatched data. The project was conducted in collaboration with the British Orthopaedic Trainees Association, British Elbow and Shoulder Society, Royal College of Surgeons of England and the British Orthopaedic Association. A full list of contributors is available at the end of this section. As a result of this exercise there has been a significant increase in the number of elbow replacement cases available for analysis in this year's report.

Figure 3.E1 Elbow cohort flow diagram.



** Reasons not necessarily mutually exclusive*

A total of 7,280 primary replacements were available for analysis for a total of 7,045 patients (Figure 3.E1, page 229). Of these patients, 235 had documented elbow replacements on both left and right sides, and in 14 patients these were both performed on the same day (bilateral).

The majority of replacements were performed on females (66.9%) and the median age at the time of primary operation was 65 years (IQR 53 to 74), with an overall range of 14 to 99 years.

Table 3.E1 (page 231) shows that the annual number of primary elbow replacements entered into the registry has increased since 2012 until the impact of COVID-19 in 2020 and 2021. While the increase in the early years is in part due to improvement in data capture, the consistent increase observed year-on-year from 2015 to 2019 mostly reflects an increase in the volume of procedures, improved reporting of radial head replacement and distal humeral hemiarthroplasties, or a combination of these factors.

Table 3.E1 provides a breakdown by the stated type of replacement. Of all procedures, including the unconfirmed, 54.6% were classified as a total replacement. A total of 440 (6.0%) primary elbow replacements had an unconfirmed status.

Table 3.E2 (page 232) details the type of primary operation in each year, and we show that 3,770 (51.8%) elbow replacements have been carried out for acute trauma and captured in the registry. These have been separated from the remaining 3,510 cases performed for elective indications in the rest of this section. Over half (63.2%) of the elbow procedures performed for trauma were confirmed radial head replacements.

Table 3.E1 Number of primary elbow replacements by year and percentage of each type of procedure.

	Number of primaries	Year of primary									
		2012 N (%)	2013 N (%)	2014 N (%)	2015 N (%)	2016 N (%)	2017 N (%)	2018 N (%)	2019 N (%)	2020 N (%)	2021 N (%)
All cases	7,280	422 (100.0)	642 (100.0)	657 (100.0)	711 (100.0)	739 (100.0)	822 (100.0)	879 (100.0)	991 (100.0)	657 (100.0)	760 (100.0)
Confirmed elbow replacements	6,840	369 (87.4)	566 (88.2)	630 (95.9)	664 (93.4)	683 (92.4)	766 (93.2)	825 (93.9)	965 (97.4)	633 (96.3)	739 (97.2)
Total elbow replacement	3,550	232 (55.0)	397 (61.8)	402 (61.2)	415 (58.4)	395 (53.5)	447 (54.4)	389 (44.3)	383 (38.6)	224 (34.1)	266 (35.0)
Total elbow replacement inc. radial head replacement	66	10 (2.4)	<4 (0.5)	11 (1.7)	4 (0.6)	6 (0.8)	4 (0.5)	9 (1.0)	9 (0.9)	<4 (0.5)	7 (0.9)
Radial head replacement	2,861	113 (26.8)	153 (23.8)	214 (32.6)	242 (34.0)	282 (38.2)	311 (37.8)	373 (42.4)	477 (48.1)	327 (49.8)	369 (48.6)
Lateral resurfacing	29	11 (2.6)	13 (2.0)	<4 (0.5)	0 (0.0)	0 (0.0)	<4 (0.1)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)
Distal humeral hemiarthroplasty	334	<4 (0.7)	0 (0.0)	0 (0.0)	<4 (0.4)	0 (0.0)	<4 (0.4)	54 (6.1)	96 (9.7)	78 (11.9)	97 (12.8)
Unconfirmed elbow replacements	440	53 (12.6)	76 (11.8)	27 (4.1)	47 (6.6)	56 (7.6)	56 (6.8)	54 (6.1)	26 (2.6)	24 (3.7)	21 (2.8)
Unconfirmed total elbow replacement	360	46 (10.9)	73 (11.4)	22 (3.3)	44 (6.2)	50 (6.8)	47 (5.7)	43 (4.9)	15 (1.5)	11 (1.7)	9 (1.2)
Unconfirmed radial head replacement	55	<4 (0.7)	<4 (0.3)	5 (0.8)	<4 (0.4)	5 (0.7)	6 (0.7)	7 (0.8)	9 (0.9)	7 (1.1)	8 (1.1)
Unconfirmed lateral resurfacing	12	4 (0.9)	<4 (0.2)	0 (0.0)	0 (0.0)	<4 (0.1)	<4 (0.2)	<4 (0.2)	0 (0.0)	<4 (0.2)	<4 (0.1)
Unconfirmed distal humeral hemiarthroplasty	13	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.1)	<4 (0.2)	<4 (0.2)	5 (0.8)	<4 (0.4)

Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form, or with no component data in the record, are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E2 Types of primary elbow procedures used in acute trauma and elective cases by year and type of primary operation.

		Number of primaries	Year of primary									
			2012 N (%)	2013 N (%)	2014 N (%)	2015 N (%)	2016 N (%)	2017 N (%)	2018 N (%)	2019 N (%)	2020 N (%)	2021 N (%)
Acute trauma	All cases	3,770	158 (100.0)	249 (100.0)	279 (100.0)	338 (100.0)	349 (100.0)	382 (100.0)	470 (100.0)	592 (100.0)	459 (100.0)	494 (100.0)
	Confirmed elbow replacements	**3,544**	**139 (88.0)**	**224 (90.0)**	**266 (95.3)**	**317 (93.8)**	**320 (91.7)**	**342 (89.5)**	**434 (92.3)**	**576 (97.3)**	**442 (96.3)**	**484 (98.0)**
	Total elbow replacement	857	47 (29.7)	93 (37.3)	88 (31.5)	113 (33.4)	92 (26.4)	89 (23.3)	79 (16.8)	87 (14.7)	89 (19.4)	80 (16.2)
	Total elbow replacement inc. radial head replacement	<4	<4 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)	0 (0.0)
	Radial head replacement	2,384	89 (56.3)	131 (52.6)	178 (63.8)	201 (59.5)	228 (65.3)	250 (65.4)	311 (66.2)	400 (67.6)	283 (61.7)	313 (63.4)
	Lateral resurfacing	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Distal humeral hemiarthroplasty	301	<4 (1.3)	0 (0.0)	0 (0.0)	<4 (0.9)	0 (0.0)	<4 (0.8)	44 (9.4)	88 (14.9)	70 (15.3)	91 (18.4)
	Unconfirmed elbow replacements	**226**	**19 (12.0)**	**25 (10.0)**	**13 (4.7)**	**21 (6.2)**	**29 (8.3)**	**40 (10.5)**	**36 (7.7)**	**16 (2.7)**	**17 (3.7)**	**10 (2.0)**
	Unconfirmed total elbow replacement	172	16 (10.1)	24 (9.6)	8 (2.9)	20 (5.9)	24 (6.9)	33 (8.6)	29 (6.2)	7 (1.2)	6 (1.3)	5 (1.0)
	Unconfirmed radial head replacement	44	<4 (1.9)	<4 (0.4)	5 (1.8)	<4 (0.3)	5 (1.4)	5 (1.3)	6 (1.3)	7 (1.2)	7 (1.5)	4 (0.8)
	Unconfirmed lateral resurfacing	<4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Unconfirmed distal humeral hemiarthroplasty	9	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.3)	<4 (0.2)	<4 (0.3)	4 (0.9)	<4 (0.2)
Elective	All cases	3,510	264 (100.0)	393 (100.0)	378 (100.0)	373 (100.0)	390 (100.0)	440 (100.0)	409 (100.0)	399 (100.0)	198 (100.0)	266 (100.0)
	Confirmed elbow replacements	**3,296**	**230 (87.1)**	**342 (87.0)**	**364 (96.3)**	**347 (93.0)**	**363 (93.1)**	**424 (96.4)**	**391 (95.6)**	**389 (97.5)**	**191 (96.5)**	**255 (95.9)**
	Total elbow replacement	2,693	185 (70.1)	304 (77.4)	314 (83.1)	302 (81.0)	303 (77.7)	358 (81.4)	310 (75.8)	296 (74.2)	135 (68.2)	186 (69.9)
	Total elbow replacement inc. radial head replacement	64	9 (3.4)	<4 (0.8)	11 (2.9)	4 (1.1)	6 (1.5)	4 (0.9)	9 (2.2)	8 (2.0)	<4 (1.5)	7 (2.6)
	Radial head replacement	477	24 (9.1)	22 (5.6)	36 (9.5)	41 (11.0)	54 (13.8)	61 (13.9)	62 (15.2)	77 (19.3)	44 (22.2)	56 (21.1)
	Lateral resurfacing	29	11 (4.2)	13 (3.3)	<4 (0.8)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)	0 (0.0)	<4 (0.5)	0 (0.0)
	Distal humeral hemiarthroplasty	33	<4 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	10 (2.4)	8 (2.0)	8 (4.0)	6 (2.3)
	Unconfirmed elbow replacements	**214**	**34 (12.9)**	**51 (13.0)**	**14 (3.7)**	**26 (7.0)**	**27 (6.9)**	**16 (3.6)**	**18 (4.4)**	**10 (2.5)**	**7 (3.5)**	**11 (4.1)**
	Unconfirmed total elbow replacement	188	30 (11.4)	49 (12.5)	14 (3.7)	24 (6.4)	26 (6.7)	14 (3.2)	14 (3.4)	8 (2.0)	5 (2.5)	4 (1.5)
	Unconfirmed radial head replacement	11	0 (0.0)	<4 (0.3)	0 (0.0)	<4 (0.5)	0 (0.0)	<4 (0.2)	<4 (0.2)	<4 (0.5)	0 (0.0)	4 (1.5)
	Unconfirmed lateral resurfacing	11	4 (1.5)	<4 (0.3)	0 (0.0)	0 (0.0)	<4 (0.3)	<4 (0.2)	<4 (0.5)	0 (0.0)	<4 (0.5)	<4 (0.4)
	Unconfirmed distal humeral hemiarthroplasty	4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)	<4 (0.5)	<4 (0.8)

Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form, or with no component data in the record, are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.,

Figure 3.E2 and Figure 3.E3 (page 234) show the yearly number of primary elbow replacements performed for elective and acute trauma indications respectively. Elective and acute trauma procedures have been stratified by total elbow replacements (with or without a radial head replacement), radial head replacements and distal humeral hemiarthroplasty. Please note the difference in scale of the y-axis between each sub-plot. Each bar in the figure is further stratified by the volume of procedures that the surgeon conducted in that year across both elective and acute trauma settings i.e. if a surgeon performed 12 elective primary total elbow replacement procedures and 12 acute trauma primary total elbow replacement procedures their annual total volume would be 24 procedures. Those 24 procedures would contribute to the dark purple sub-division in both elective and acute trauma figures shown here.

Figure 3.E2 shows that the volume of primary total elbow replacements has marginally increased over the last five years (except for 2020 and 2021 due to the impact of COVID-19), with the number of surgeons performing one or two procedures annually falling. Elective radial head replacements are increasingly being recorded in the registry, however the majority of consultants only perform one or two procedures annually. Figure 3.E3 shows the volume of primary total elbow replacements performed for acute trauma staying relatively constant over the last five years despite the impact of COVID-19. Prior to the impact of COVID-19, there was an increasing proportion of primary total elbow replacements performed by higher volume elbow surgeons i.e. those performing more than 13 procedures a year. Radial head replacement for acute trauma was steadily increasing in volume until the impact of COVID-19 when numbers fell and have now partially recovered. The proportion of consultants performing three or more procedures per year has also been increasing, indicating a degree of specialisation.

Figure 3.E2 Frequency of primary elbow replacements within elective cases stratified by procedure type, bars stacked by volume per consultant per year.

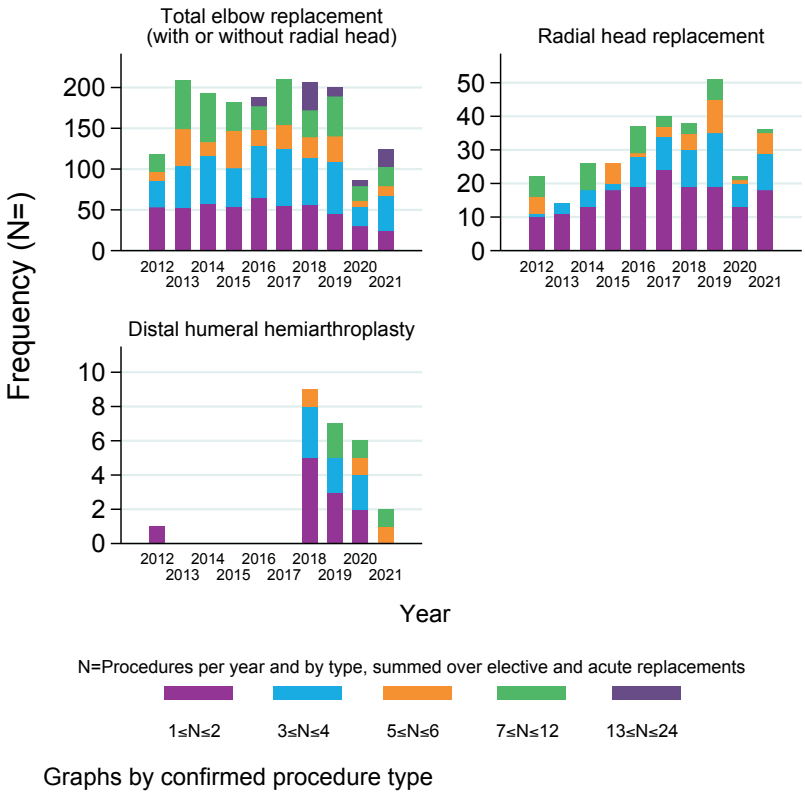


Figure 3.E3 Frequency of primary elbow replacements within acute trauma cases stratified by procedure type, bars stacked by volume per consultant per year.

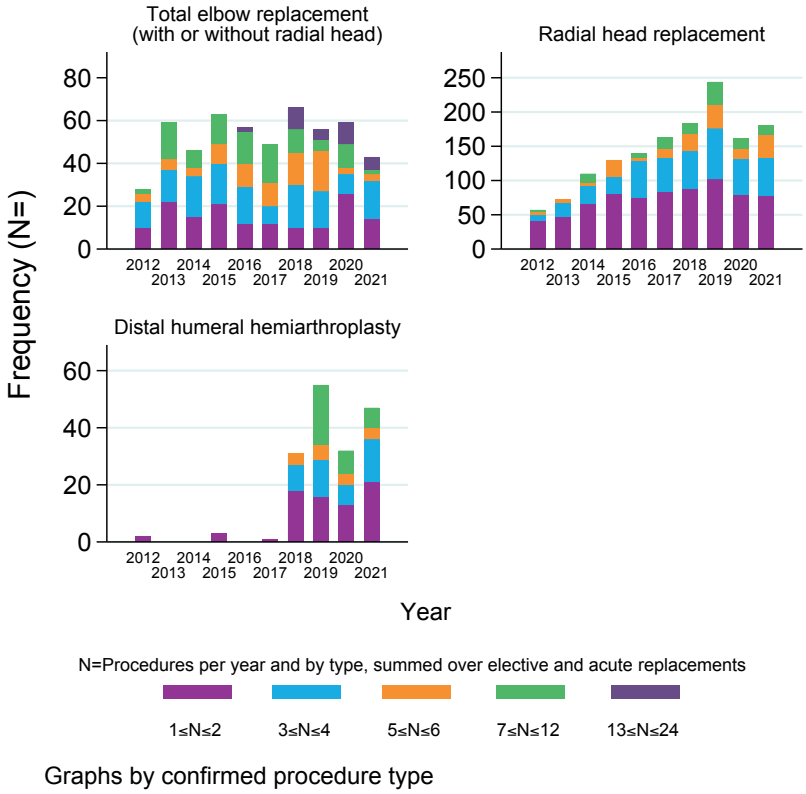


Table 3.E3 (page 235) describes the indications for the primary operation separately by type of primary elbow replacement. Primary operations with an unconfirmed procedure type are excluded from this table.

Please note that the indications for primary elbow replacement are not mutually exclusive since more than one indication could have been provided. Only one indication for surgery, as defined in Table 3.E3, was given for all 3,544 acute trauma cases with a confirmed type of primary procedure. In 152 (4.6%) of the 3,296 elective cases with a confirmed type of primary, more than one indication was given.

Table 3.E3 Indications for main confirmed types of primary elbow replacements, by year and type of primary operation.

	Year of primary	Number of primaries	Acute trauma	Elective						
			Number of cases (%)	Number of cases (%)	Number (%)* for each indication (amongst elective cases only)					
					Osteoarthritis	Inflammatory arthropathy	Trauma sequelae	Essex Lopresti	Avascular necrosis	Other indication
Total elbow replacement	All cases	3,550	857 (24.1)	2,693 (75.9)	934 (34.7)	1,279 (47.5)	480 (17.8)	4 (0.1)	6 (0.2)	127 (4.7)
	2012	232	47 (20.3)	185 (79.7)	61 (33.0)	80 (43.2)	42 (22.7)	<4 (0.5)	0 (0.0)	12 (6.5)
	2013	397	93 (23.4)	304 (76.6)	115 (37.8)	149 (49.0)	34 (11.2)	<4 (0.3)	<4 (0.3)	19 (6.3)
	2014	402	88 (21.9)	314 (78.1)	117 (37.3)	157 (50.0)	40 (12.7)	0 (0.0)	0 (0.0)	15 (4.8)
	2015	415	113 (27.2)	302 (72.8)	105 (34.8)	155 (51.3)	41 (13.6)	0 (0.0)	<4 (0.7)	17 (5.6)
	2016	395	92 (23.3)	303 (76.7)	104 (34.3)	151 (49.8)	51 (16.8)	0 (0.0)	0 (0.0)	12 (4.0)
	2017	447	89 (19.9)	358 (80.1)	117 (32.7)	180 (50.3)	63 (17.6)	<4 (0.3)	<4 (0.3)	13 (3.6)
	2018	389	79 (20.3)	310 (79.7)	107 (34.5)	160 (51.6)	52 (16.8)	<4 (0.3)	0 (0.0)	10 (3.2)
	2019	383	87 (22.7)	296 (77.3)	98 (33.1)	136 (45.9)	62 (20.9)	0 (0.0)	0 (0.0)	14 (4.7)
	2020	224	89 (39.7)	135 (60.3)	43 (31.9)	48 (35.6)	42 (31.1)	0 (0.0)	0 (0.0)	7 (5.2)
	2021	266	80 (30.1)	186 (69.9)	67 (36.0)	63 (33.9)	53 (28.5)	0 (0.0)	<4 (1.1)	8 (4.3)
Radial head replacement	All cases	2,861	2,384	477	59	4	335	36	4	50
	2012	113	89	24	<4	0	14	4	0	4
	2013	153	131	22	4	0	15	0	0	4
	2014	214	178	36	0	<4	28	4	0	<4
	2015	242	201	41	5	0	31	<4	<4	<4
	2016	282	228	54	7	0	41	<4	<4	4
	2017	311	250	61	7	0	44	5	0	6
	2018	373	311	62	10	0	43	4	0	6
	2019	477	400	77	11	<4	48	5	<4	13
	2020	327	283	44	8	0	26	8	0	<4
	2021	369	313	56	5	<4	45	<4	0	4
Distal humeral hemiarthroplasty	All cases	334	301	33	8	<4	23	0	0	<4
	2012	<4	<4	<4	0	0	<4	0	0	0
	2013	0	0	0	0	0	0	0	0	0
	2014	0	0	0	0	0	0	0	0	0
	2015	<4	<4	0	0	0	0	0	0	0
	2016	0	0	0	0	0	0	0	0	0
	2017	<4	<4	0	0	0	0	0	0	0
	2018	54	44	10	<4	<4	6	0	0	0
	2019	96	88	8	<4	0	8	0	0	0
	2020	78	70	8	<4	0	5	0	0	<4
	2021	97	91	6	<4	0	<4	0	0	0

*Percentages are not presented where numbers are too few to be meaningful; please note the listed reasons are not mutually exclusive as more than one reason could have been stated.
Note: Procedures with unconfirmed prostheses and confirmed lateral resurfacing and confirmed total elbow replacements including a radial head replacement were not reported in this table for clarity.
Note: Distal humeral hemiarthroplasty started to be reported in MDSv7 released in June 2018.

Table 3.E4 Number of units and consultant surgeons (cons) providing primary elbow replacements during each year from the last three years, by region.

(a) All primary elbow replacements (including the confirmed and unconfirmed total, radial head, lateral resurfacing and distal humeral hemiarthroplasty replacements.

Region	Year of primary														
	2019					2020					2021				
	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)
All regions	991	194	3 (1 to 7)	318	6 (3 to 11)	657	159	2 (1 to 6)	245	5 (2 to 8)	760	167	3 (1 to 7)	255	6 (3 to 9)
East Midlands	80	12	5.5 (3 to 10)	29	7 (5 to 12)	45	8	3.5 (2.5 to 8)	18	5 (3 to 15)	58	13	4 (3 to 5)	24	4 (4 to 7)
East of England	85	14	3.5 (1 to 10)	23	10 (4 to 14)	48	9	6 (3 to 6)	18	6 (4 to 10)	76	15	2 (2 to 8)	27	7 (2 to 8)
London	92	27	2 (1 to 4)	34	3.5 (2 to 8)	98	32	2 (1 to 3)	43	2 (2 to 6)	83	23	2 (1 to 5)	32	4 (2 to 9)
North East	80	13	7 (3 to 9)	21	8 (6 to 9)	66	15	4 (1 to 7)	21	6 (6 to 10)	91	11	6 (3 to 15)	19	12 (6 to 16)
North West	165	32	3 (1 to 7.5)	57	6 (3 to 10)	75	21	2 (1 to 5)	36	5 (3 to 7)	115	27	3 (1 to 6)	36	5.5 (3 to 8)
South Central	47	7	8 (2 to 11)	19	9 (8 to 11)	34	7	3 (1 to 8)	11	3 (3 to 12)	49	9	2 (1 to 9)	16	9 (3.5 to 18)
South East Coast	85	21	3 (1 to 7)	29	5 (3 to 8)	82	20	2 (1 to 6)	23	5 (4 to 7)	60	20	2 (1 to 4)	23	4 (2 to 5)
South West	120	17	3 (2 to 15)	29	15 (3 to 19)	63	10	5.5 (1 to 9)	22	7 (4 to 9)	61	15	2 (2 to 8)	25	6 (2 to 9)
Wales	43	12	3.5 (1.5 to 4)	10	4 (3 to 4)	16	7	1 (1 to 3)	7	2 (1 to 3)	23	8	3 (1 to 4)	8	3 (2 to 4)
West Midlands	90	22	2.5 (1 to 5)	40	4.5 (2.5 to 8)	47	13	3 (2 to 6)	21	6 (2 to 8)	68	11	2 (1 to 13)	25	13 (4 to 14)
Yorkshire and the Humber	104	17	3 (2 to 7)	27	7 (3 to 16)	83	17	2 (1 to 6)	25	4 (2 to 13)	76	15	3 (2 to 9)	20	5.5 (2 to 10.5)

Note: Wales includes North, Mid and Central, and South East regions.

Table 3.E4 Number of units and consultant surgeons (cons) providing primary elbow replacements during each year from the last three years, by region.

(b) All confirmed primary total elbow replacements (with or without radial head replacement).

Region	Year of primary														
	2019					2020					2021				
	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)
All regions	392	121	2 (1 to 4)	143	3 (2 to 6)	227	93	1 (1 to 3)	107	2 (1 to 4)	273	104	2 (1 to 3)	102	2.5 (1 to 4)
East Midlands	39	8	4 (2 to 6.5)	14	6 (5 to 13)	15	5	3 (1 to 3)	8	3 (2 to 5)	20	5	3 (2 to 7)	7	7 (3 to 7)
East of England	32	10	2.5 (1 to 5)	11	3 (2 to 6)	20	8	2.5 (1 to 3.5)	9	3 (2 to 4)	27	10	2 (2 to 3)	8	2 (2 to 3.5)
London	35	13	2 (1 to 3)	16	3 (2 to 7)	29	10	1.5 (1 to 2)	17	2 (1 to 10)	21	10	1 (1 to 3)	13	3 (1 to 4)
North East	32	11	3 (1 to 5)	11	4 (1 to 5)	27	12	1 (1 to 3)	12	2 (1 to 6)	23	9	2 (1 to 4)	8	2 (1 to 3.5)
North West	53	17	2 (1 to 3)	22	3 (1 to 6)	24	11	1 (1 to 3)	14	2 (1 to 3)	46	18	2 (1 to 3)	16	3 (2 to 5)
South Central	19	5	2 (2 to 6)	9	6 (2 to 6)	12	5	2 (1 to 3)	5	3 (1 to 5)	11	6	2 (1 to 2)	5	2 (2 to 3)
South East Coast	30	11	2 (1 to 4)	11	3 (2 to 4)	28	11	1 (1 to 5)	8	2 (1 to 4)	22	13	1 (1 to 2)	10	2 (1 to 2)
South West	46	12	2.5 (1.5 to 5)	10	4 (2 to 7)	9	5	2 (1 to 2)	7	2 (1 to 3)	21	10	1.5 (1 to 2)	8	2.5 (2 to 5)
Wales	20	8	2 (1.5 to 3.5)	7	2 (1 to 4)	9	7	1 (1 to 1)	6	1 (1 to 1)	10	6	1.5 (1 to 2)	6	1.5 (1 to 2)
West Midlands	38	12	2 (1.5 to 4)	17	3 (2 to 4)	21	8	2 (1 to 3)	10	3 (1 to 8)	35	7	1 (1 to 6)	12	6 (1 to 21)
Yorkshire and the Humber	48	14	2 (1 to 4)	15	3 (2 to 7)	33	11	1 (1 to 4)	11	2 (1 to 4)	37	10	2.5 (2 to 4)	9	3 (2 to 4)

Note: Wales includes North, Mid and Central, and South East regions.

Over the last three years (2019 to 2021 inclusive) 2,408 primary elbow replacements were entered into the registry, of which 892 had confirmed components consistent with a total elbow replacement (with or without radial head replacement).

Table 3.E4 (a) and Table 3.E4 (b) (page 236) show the number of all types of elbow replacement by year and NJR geographical region over this time period, together with the number of units and consultants. A list of units within each NJR region is provided in the downloads section of **reports.njrcentre.org.uk** and further information can be found on **https://surgeonprofile.njrcentre.org.uk**

The median number of elbow replacements per unit and consultant has changed very little over the last three years and remains around two to three per annum with up to six replacements per unit in the North East region and as low as two replacements per unit in the East of England region in 2021. These figures are subject to change, as some units may not have submitted all data for 2021 by the time of data analysis.

Table 3.E5 lists the brands used in elbow replacement by confirmed procedure type, with sub-division by acute trauma and elective cases.

Table 3.E5 Brands used in elbow replacement by confirmed procedure type.

		Number of primaries	Elective	Acute trauma
Total elbow replacement	All cases	3,550	2,693	857
	Linked:			
	Coonrad Morrey	1,809	1,333	476
	Discovery	904	707	197
	GSB III	51	48	<4
	Latitude EV Stem[Hum:Ulna]	199	160	39
	Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]	56	46	10
	Latitude EV Stem[Hum]Latitude Legacy Stem[Ulna]	<4	<4	0
	Latitude Legacy Stem[Hum:Ulna]	35	26	9
	Latitude Legacy Stem[Hum]Latitude Legacy Short Stem[Ulna]	38	31	7
	Latitude[Hum]Latitude EV Short Stem[Ulna]	8	6	<4
	Latitude[Hum]Latitude EV Stem[Ulna]	35	24	11
	MUTARS Stem Cementless[Hum]MUTARS[Ulna]	<4	<4	0
	Nexel	295	203	92
	Unlinked:			
	IBP	8	8	0
	Latitude EV Stem[Hum:Ulna]	41	34	7
	Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]	25	24	<4
	Latitude Legacy Stem[Hum:Ulna]	9	9	0
	Latitude Legacy Stem[Hum]Latitude Legacy Short Stem[Ulna]	20	20	0
	Latitude[Hum]Latitude EV Short Stem[Ulna]	<4	0	<4
	Latitude[Hum]Latitude EV Stem[Ulna]	5	4	<4
	NES	<4	<4	0

Note: Procedures of unconfirmed type are not reported in this table.
Note: Distal humeral hemiarthroplasty started to be reported in MDSv7 released in June 2018.
Note: [Hum]=Humeral, [Ulna]=Ulna, [Rad]=Radial Head, [LHR]=Lateral humeral resurfacing, [LRR]=Lateral radial resurfacing, [DHH]=Distal humeral hemiarthroplasty.

Table 3.E5 (continued)

		Number of primaries	Elective	Acute trauma
Total elbow replacement inc. radial head replacement	All cases	66	64	<4
	Linked:			
	Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Latitude EV Stem[Hum]Latitude EV Stem[Ulna] Latitude (Legacy | EV)[Rad]	5	4	<4
	Latitude Legacy Stem[Hum]Latitude EV Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Latitude Legacy Stem[Hum]Latitude Legacy Short Stem[Ulna]Latitude (Legacy | EV)[Rad]	7	6	<4
	Latitude Legacy Stem[Hum]Latitude Legacy Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Latitude[Hum]Latitude EV Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Unlinked:			
	Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Latitude EV Stem[Hum]Latitude EV Stem[Ulna] Latitude (Legacy | EV)[Rad]	8	8	0
	Latitude EV Stem[Hum]Latitude EV Stem[Ulna] Latitude EV[Rad]	<4	<4	0
	Latitude Legacy Stem[Hum]Latitude Legacy Short Stem[Ulna]Latitude (Legacy | EV)[Rad]	24	24	0
	Latitude Legacy Stem[Hum]Latitude Legacy Stem[Ulna]Latitude (Legacy | EV)[Rad]	7	7	0
	Latitude[Hum]Latitude EV Short StemUndefined|Custom[Ulna][Rad]	<4	<4	0
	Latitude[Hum]Latitude EV Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Latitude[Hum]Latitude EV Stem[Ulna]Latitude EV[Rad]	<4	<4	0
	Latitude[Hum]Latitude EV Stem[Ulna] Latitude[Rad]	<4	<4	0

Note: Procedures of unconfirmed type are not reported in this table.
Note: Distal humeral hemiarthroplasty started to be reported in MDSv7 released in June 2018.
Note: [Hum]=Humeral, [Ulna]=Ulna, [Rad]=Radial Head, [LHR]=Lateral humeral resurfacing, [LRR]=Lateral radial resurfacing, [DHH]=Distal humeral hemiarthroplasty.

Table 3.E5 (continued)

		Number of primaries	Elective	Acute trauma
Radial head replacement	All cases	2,861	477	2,384
	Bipolar:			
	Latitude (Legacy | EV)[Rad]	<4	0	<4
	RHS[Rad]	74	25	49
	rHead Recon[Rad]	12	5	7
	Monopolar:			
	Anatomic[Rad]	1,612	252	1,360
	Ascension[Rad]	117	28	89
	Corin[Rad]	92	14	78
	Evolve Proline[Rad]	590	77	513
	ExploR[Rad]	189	32	157
	Liverpool[Rad]	31	4	27
	MoPyC[Rad]	13	5	8
	Uni-Radial Elbow[Rad]	39	13	26
Lateral resurfacing	All cases	29	29	0
	LRE[LHR:LRR]	28	28	0
	Uni-Elbow[LHR:LRR]	<4	<4	0
Distal humeral hemiarthroplasty	All cases	334	33	301
	Latitude EV Stem[DHH]	258	24	234
	Latitude Legacy Stem[DHH]	23	5	18
	Latitude[DHH]	53	4	49

Note: Procedures of unconfirmed type are not reported in this table.
Note: Distal humeral hemiarthroplasty started to be reported in MDSv7 released in June 2018.
Note: [Hum]=Humeral, [Ulna]=Ulna, [Rad]=Radial Head, [LHR]=Lateral humeral resurfacing, [LRR]=Lateral radial resurfacing, [DHH]=Distal humeral hemiarthroplasty.

The top five constructs used in total elbow replacement by volume (Coonrad Morrey[Hum:Ulna], Discovery[Hum:Ulna], Nexel[Hum:Ulna], Latitude EV Stem[Hum:Ulna], Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]) account for nearly 92.1% of total elbow replacements performed. All total elbow replacements with radial head replacement were performed using the Latitude family of implants. One implant (RHS[Rad]) accounts for 85.1% of the bipolar radial head replacements and two implants, (Anatomic[Rad] and Evolve Proline[Rad]), account for 82.1% of the monopolar radial head replacements. Nearly all (96.6%) lateral resurfacing procedures have been performed using the LRE[LHR:LRR] brand. The Latitude EV Stem[DHH] was used for 77.2% of distal humeral hemiarthroplasty procedures.

3.5.2 Revisions after primary elbow replacement surgery

We found that a total of 300 elbow primaries in the registry (77 acute trauma cases and 223 elective) had linked revision procedures recorded up to the end of 2021, including 14 excision procedures, 182 single-stage revisions, 13 DAIRs (nine with modular exchange and four without modular exchange) and 75 stage one of a two-stage procedure.

Table 3.E6 KM estimates of cumulative revision (95% CI) by primary elbow procedures for acute trauma and elective cases. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

		Number of primaries	Age (Median, IQR)	Male (%)	Time since primary								
					1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
All acute trauma and elective cases		7,280	65 (53 to 74)	33	1.31 (1.06-1.60)	2.60 (2.24-3.02)	3.65 (3.21-4.16)	4.49 (3.97-5.08)	4.94 (4.37-5.57)	5.59 (4.95-6.30)	6.19 (5.48-7.00)	6.38 (5.63-7.23)	6.82 (5.88-7.90)
Acute trauma	All acute trauma cases	3,770	62 (48 to 74)	34	1.03 (0.75-1.42)	1.70 (1.31-2.20)	2.02 (1.58-2.57)	2.29 (1.81-2.91)	2.51 (1.98-3.18)	2.70 (2.12-3.43)	2.97 (2.30-3.81)	2.97 (2.30-3.81)	*2.97 (2.30-3.81)*
	Total elbow replacement	857	77 (71 to 83)	17	1.38 (0.76-2.47)	2.39 (1.51-3.78)	3.24 (2.16-4.85)	3.89 (2.65-5.72)	4.74 (3.26-6.87)	*5.46 (3.77-7.88)*	*5.46 (3.77-7.88)*	*5.46 (3.77-7.88)*	*5.46 (3.77-7.88)*
	Total elbow replacement inc. radial head replacement	<4	75 (71 to 79)	0									
	Radial head replacement	2,384	53 (41 to 63)	43	0.70 (0.43-1.14)	1.06 (0.71-1.60)	1.19 (0.80-1.76)	1.36 (0.93-2.00)	1.36 (0.93-2.00)	1.36 (0.93-2.00)	1.76 (1.14-2.70)	*1.76 (1.14-2.70)*	*1.76 (1.14-2.70)*
	Distal humeral hemiarthroplasty	301	71 (64 to 79)	18	*2.55 (1.22-5.28)*	*4.34 (2.30-8.13)*	*5.37 (2.85-10.00)*						
	Unconfirmed total elbow replacement	172	75 (65 to 82.5)	22	*1.18 (0.30-4.64)*	*1.84 (0.60-5.62)*	*1.84 (0.60-5.62)*	*1.84 (0.60-5.62)*	*1.84 (0.60-5.62)*	*1.84 (0.60-5.62)*	*1.84 (0.60-5.62)*	*1.84 (0.60-5.62)*	
	Unconfirmed radial head replacement	44	55 (43.5 to 61.5)	41	*2.27 (0.32-15.06)*	*4.78 (1.21-17.82)*	*4.78 (1.21-17.82)*	*4.78 (1.21-17.82)*	*4.78 (1.21-17.82)*	*4.78 (1.21-17.82)*			
	Unconfirmed lateral resurfacing	<4	74 (74 to 74)	100									
	Unconfirmed distal humeral hemiarthroplasty	9	71 (61 to 77)	33									

Note: Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time period.
Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form, or with no component data in the record, are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E6 (continued)

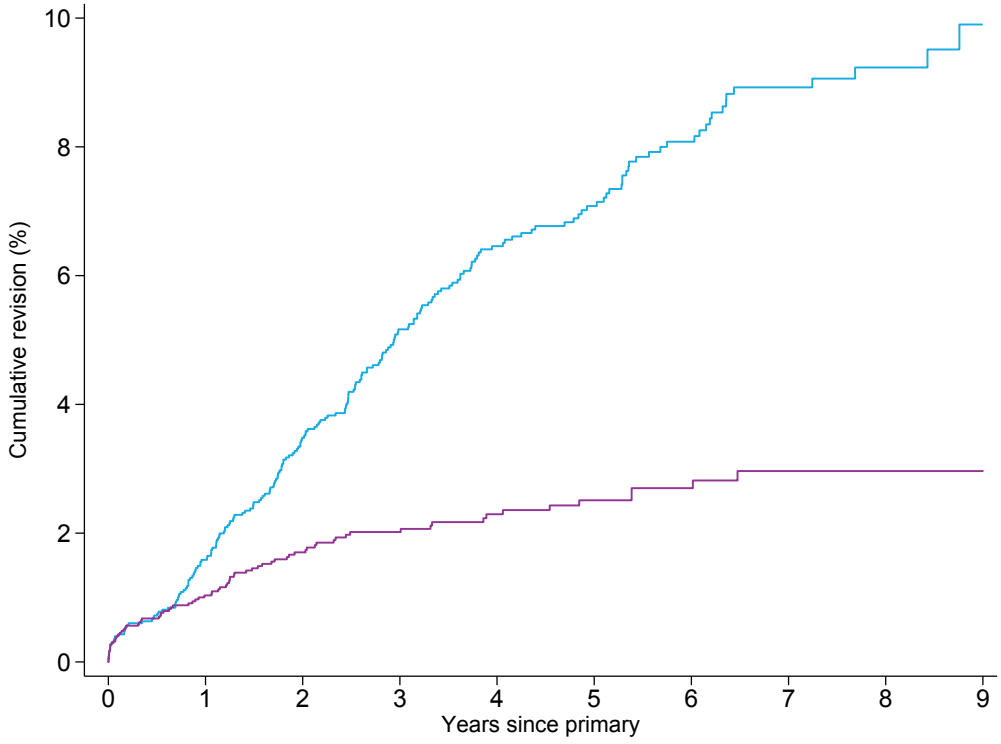
		Number of primaries	Age (Median, IQR)	Male (%)	Time since primary								
					1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
Elective	**All elective cases**	**3,510**	**67 (57 to 75)**	**33**	**1.59 (1.21-2.07)**	**3.48 (2.90-4.18)**	**5.17 (4.43-6.02)**	**6.46 (5.60-7.43)**	**7.08 (6.16-8.13)**	**8.08 (7.05-9.25)**	**8.92 (7.78-10.23)**	**9.23 (8.02-10.61)**	*9.90 (8.43-11.61)*
	Total elbow replacement	2,693	69 (60 to 76)	30	1.17 (0.82-1.67)	3.15 (2.52-3.92)	4.83 (4.03-5.79)	6.16 (5.22-7.27)	6.97 (5.94-8.18)	8.10 (6.92-9.48)	8.85 (7.55-10.36)	9.27 (7.87-10.91)	*9.27 (7.87-10.91)*
	Total elbow replacement inc. radial head replacement	64	64 (49.5 to 71.5)	36	*3.37 (0.85-12.83)*	*7.02 (2.69-17.66)*	*7.02 (2.69-17.66)*	*7.02 (2.69-17.66)*	*7.02 (2.69-17.66)*	*7.02 (2.69-17.66)*	*11.91 (4.52-29.35)*		
	Radial head replacement	477	52 (41 to 63)	48	2.46 (1.37-4.40)	4.01 (2.51-6.39)	4.62 (2.96-7.18)	*4.98 (3.22-7.66)*	*4.98 (3.22-7.66)*	*4.98 (3.22-7.66)*	*5.82 (3.66-9.22)*	*5.82 (3.66-9.22)*	*5.82 (3.66-9.22)*
	Lateral resurfacing	29	54 (43 to 61)	66	*3.45 (0.49-22.05)*	*3.45 (0.49-22.05)*	*3.45 (0.49-22.05)*	*7.02 (1.80-25.29)*	*7.02 (1.80-25.29)*	*7.02 (1.80-25.29)*	*7.02 (1.80-25.29)*	*7.02 (1.80-25.29)*	*7.02 (1.80-25.29)*
	Distal humeral hemiarthroplasty	33	73 (67 to 81)	21	*6.35 (1.63-23.10)*	*10.81 (3.55-30.43)*							
	Unconfirmed total elbow replacement	188	67 (57 to 75)	30	*3.25 (1.47-7.09)*	*4.40 (2.22-8.61)*	*8.69 (5.32-14.02)*	*11.31 (7.35-17.20)*	*11.31 (7.35-17.20)*	*12.92 (8.58-19.21)*	*12.92 (8.58-19.21)*	*12.92 (8.58-19.21)*	*12.92 (8.58-19.21)*
	Unconfirmed radial head replacement	11	65 (47 to 76)	27									
	Unconfirmed lateral resurfacing	11	59 (51 to 68)	36	*0.00 (.-.)*								
	Unconfirmed distal humeral hemiarthroplasty	4	71.5 (54 to 80.5)	25									

Note: Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time period.
Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form, or with no component data in the record, are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E6 (page 241) shows Kaplan-Meier estimates of the cumulative percentage probability of revision up to nine years after the primary operation, together with 95% Confidence Intervals for all cases and for acute trauma and elective cases separately.

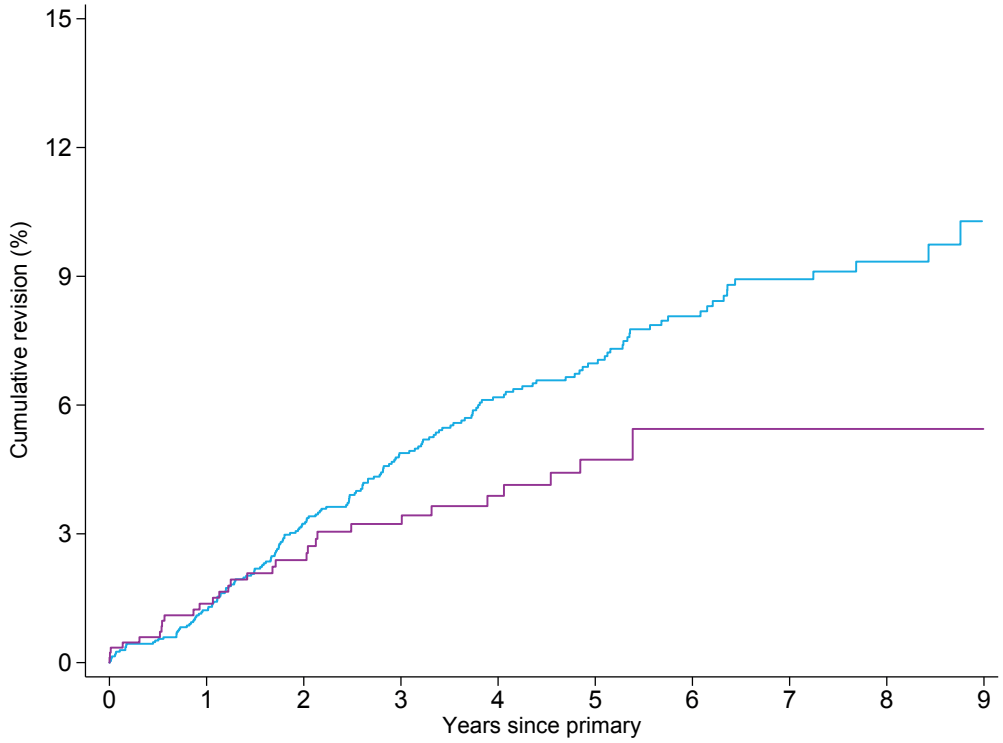
There is a higher cumulative revision rate for all elbow replacements for elective indications compared to trauma. Figure 3.E4 shows Kaplan-Meier estimates of the cumulative percentage probability of revision after primary elbow replacement, divided into acute trauma and elective cases. It should be noted that there are substantial differences in the proportions of different types of elbow replacement in the elective and trauma group that are likely to account for the differences observed. Total elbow replacement makes up a higher proportion of procedures in elective cases (78.5%) than trauma (22.8%), whereas isolated radial head replacement is more commonly performed in trauma cases (63.2%) than elective (13.6%).

Figure 3.E4 KM estimates of cumulative revision of primary elbow replacement by acute trauma and elective cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
Acute trauma	3,770	3,166	2,648	2,025	1,542	1,165	817	528	298	*103*
Elective	3,510	3,139	2,825	2,348	1,887	1,431	1,051	736	446	*176*

Figure 3.E5 KM estimates of cumulative revision of primary total elbow replacement (with or without a radial head replacement) by acute trauma and elective cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
Acute trauma	859	720	602	484	385	299	*208*	*131*	*80*	*21*
Elective	2,757	2,489	2,245	1,872	1,502	1,121	815	561	327	*124*

For the sub-group of total elbow replacement, shown in Figure 3.E5, we found that the survival of total replacements was comparable for trauma and elective indications up to two years. From two years post-operation onwards, the revision rates were higher for the elective total elbow replacements, but the data for acute trauma is less certain due to the low numbers in the registry and because the confidence intervals of the estimates in both groups overlap. There is insufficient data to compare lateral resurfacing, distal humeral hemiarthroplasty, and the other unconfirmed types of primary procedure between elective and trauma indications.

Figure 3.E6 KM estimates of cumulative revision of primary radial head replacement by acute trauma and elective cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

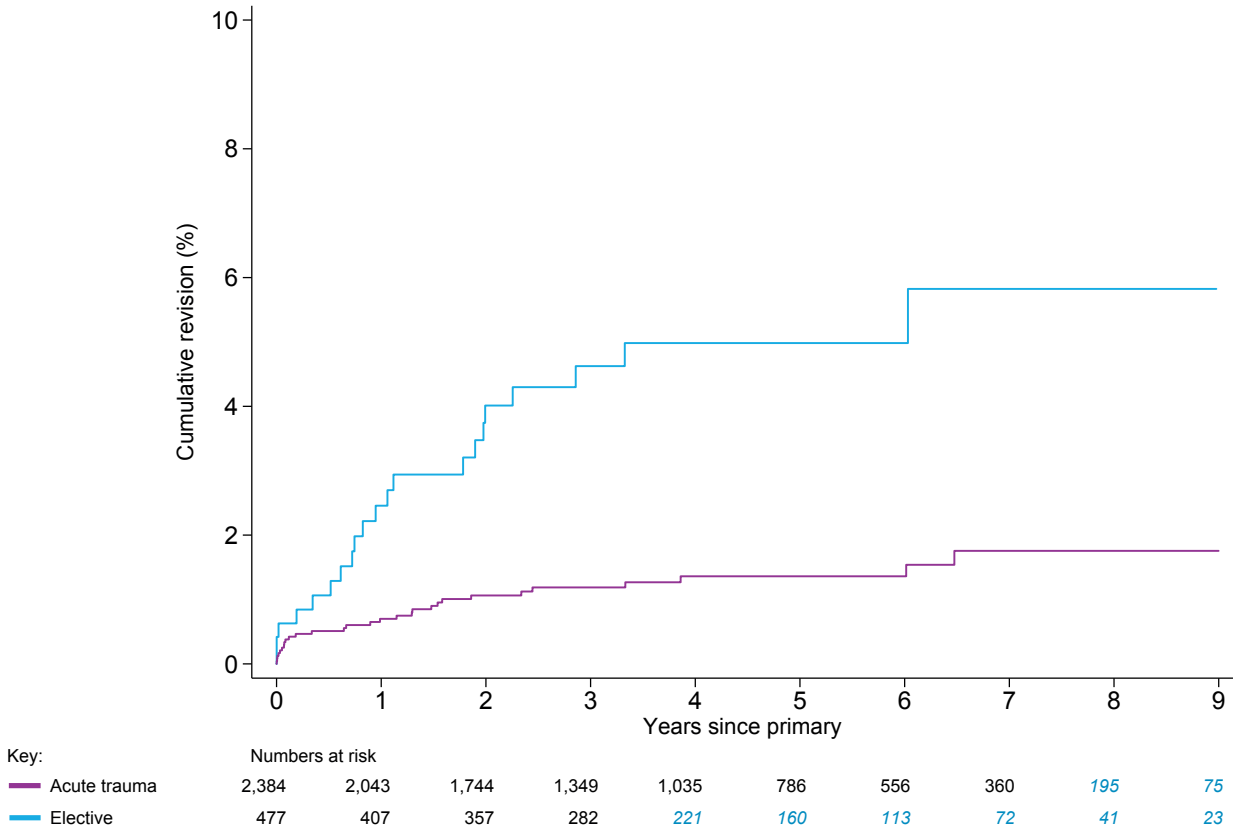


Figure 3.E6 shows Kaplan-Meier estimates of the cumulative percentage probability of revision by acute trauma and the elective cases in radial head replacements. Revision of radial head replacement appears to be under-reported as they are frequently revised to an excision arthroplasty which is often poorly recorded by units.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed, and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation, and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

Figure 3.E7 KM estimates of cumulative revision of total elbow replacements and distal humeral hemiarthroplasty within the acute trauma cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

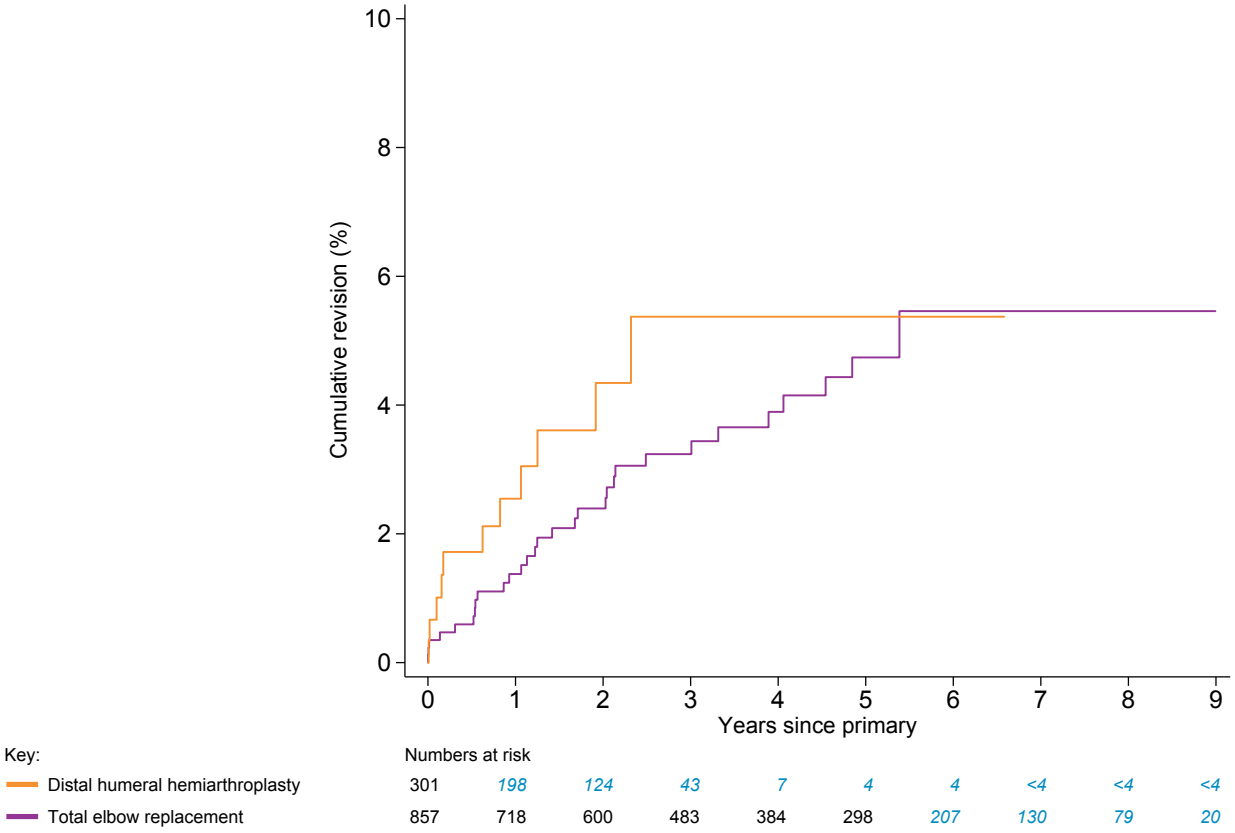
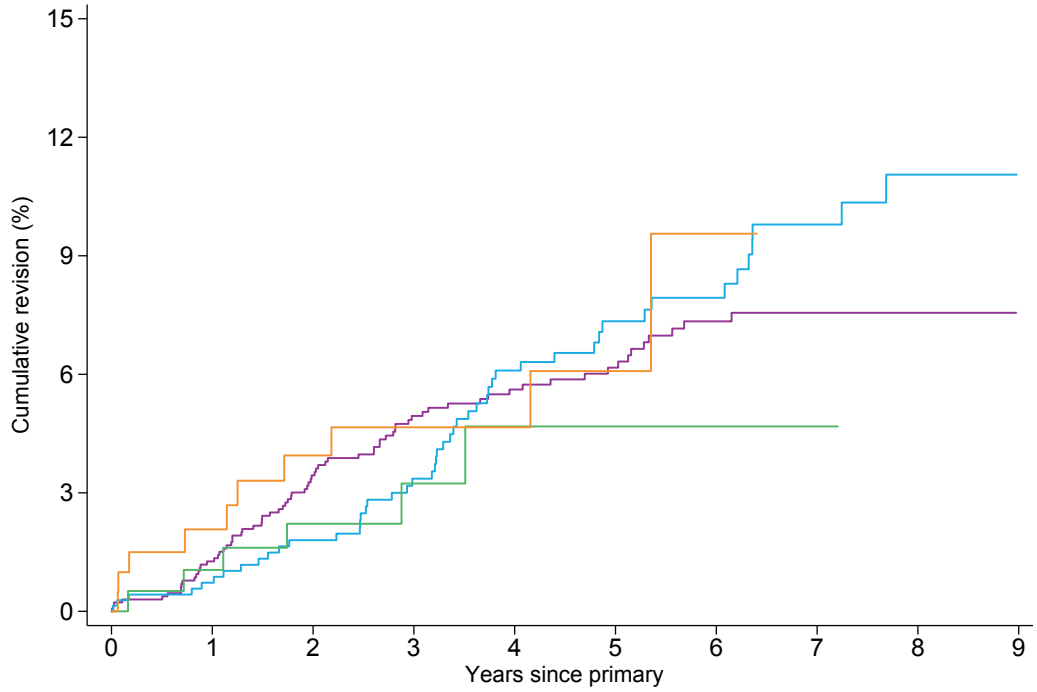


Figure 3.E7 shows cumulative rates of revision within the acute trauma cases. These differences remain uncertain as the number of procedures and the number of revisions within these groups remain low and excisions of radial head replacements are likely to have been under-reported.

There are too few cases for further sub-division into age/gender sub-groups.

Figure 3.E8 KM estimates of cumulative revision of total elbow replacements by implant brand within the elective cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points (elbow replacements with less than 100 procedures are excluded).*



Key:	Numbers at risk									
Nexel	*203*	*165*	*138*	*108*	*74*	*36*	*8*			
Latitude EV Stem	*194*	*180*	*146*	*88*	*43*	*19*	*5*	*<4*		
Discovery	707	662	610	540	441	331	267	*183*	*106*	*37*
Coonrad Morrey	1,333	1,216	1,110	936	773	607	451	316	*181*	*71*

Figure 3.E8 shows the rate of revision by implant brand within the elective cases. Brand comparisons will become more reliable as the size of the elbow cohort increases over time, and allow further stratification by patient characteristics, acute/elective status, and indication for primary surgery.

Table 3.E7 (page 248) shows the cumulative probability of revision for brands used in at least 100 primary elbow replacements with a confirmed procedure type. For total elbow replacement, the cumulative revision rates varied between brands from 0.7% to 1.8% in the first post-operative year. At five years post-operation, the rates still varied between brands from 5.4% to 7.2%. However, we note that as numbers are small, this may simply be due to chance. For radial head replacement, the cumulative revision rates varied between brands from 0.5% to 2.2% in the first post-operative year.

Table 3.E7 KM estimates of cumulative revision (95% CI) for all primary elbow procedures by implant brand. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

			Number of primaries	Age (Median,IQR)	Male (%)	Time since primary								
						1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
Total elbow replacement	Linked brands	Coonrad Morrey	1,809	72 (64 to 78)	25	1.40 (0.94-2.09)	3.23 (2.48-4.21)	4.58 (3.65-5.74)	5.16 (4.15-6.41)	5.78 (4.68-7.13)	6.79 (5.53-8.33)	6.96 (5.67-8.54)	*6.96 (5.67-8.54)*	*6.96 (5.67-8.54)*
		Discovery	904	70 (61.5 to 78)	28	0.68 (0.30-1.50)	1.89 (1.16-3.06)	3.27 (2.24-4.78)	5.51 (4.06-7.47)	6.75 (5.06-8.97)	7.49 (5.66-9.88)	*9.07 (6.89-11.88)*	*10.10 (7.62-13.34)*	*10.10 (7.62-13.34)*
		Latitude EV Stem	199	71 (62 to 77)	23	*1.54 (0.50-4.70)*	*2.74 (1.15-6.48)*	*3.90 (1.68-8.91)*	*5.40 (2.40-11.91)*	*5.40 (2.40-11.91)*				
		Nexel	295	72 (63 to 80)	28	*1.82 (0.76-4.33)*	*3.20 (1.60-6.33)*	*4.30 (2.31-7.92)*	*6.04 (3.33-10.81)*	*7.23 (4.02-12.84)*	*10.04 (5.05-19.42)*			
Radial head replacement	Mono-polar brands	Anatomic	1,612	53 (41 to 63)	43	0.99 (0.59-1.63)	1.75 (1.19-2.59)	2.05 (1.41-2.96)	2.05 (1.41-2.96)	2.05 (1.41-2.96)	2.05 (1.41-2.96)	*2.34 (1.56-3.50)*	*2.34 (1.56-3.50)*	*2.34 (1.56-3.50)*
		Ascension	117	52 (38 to 65)	45	*0.90 (0.13-6.22)*	*1.93 (0.49-7.54)*	*3.07 (1.00-9.28)*	*4.48 (1.68-11.66)*	*4.48 (1.68-11.66)*	*4.48 (1.68-11.66)*	*4.48 (1.68-11.66)*		
		Evolve Proline	590	54 (41 to 64)	45	0.52 (0.17-1.60)	0.52 (0.17-1.60)	0.52 (0.17-1.60)	*0.52 (0.17-1.60)*	*0.52 (0.17-1.60)*	*0.52 (0.17-1.60)*	*2.66 (0.86-8.08)*	*2.66 (0.86-8.08)*	*2.66 (0.86-8.08)*
		ExploR	189	51 (41 to 62)	42	*2.17 (0.82-5.68)*	*2.76 (1.16-6.51)*	*2.76 (1.16-6.51)*	*3.84 (1.68-8.67)*	*3.84 (1.68-8.67)*	*3.84 (1.68-8.67)*	*3.84 (1.68-8.67)*	*3.84 (1.68-8.67)*	
Distal humeral hemiarthroplasty		Latitude EV Stem	258	71.5 (65 to 79)	20	*2.77 (1.33-5.72)*	*5.13 (2.82-9.23)*	*5.13 (2.82-9.23)*						

Note: Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time period.
Note: Elbow replacements with less than 100 procedures are excluded from this table.

Table 3.E8 gives a breakdown of the indications for the first data-linked revision procedure. The most common indications for revision remain aseptic loosening and infection. The indications for revision were not mutually exclusive; in 29 of the 300 first revisions more than one indication was stated. A few cases (n=77) had gone on to have further revision procedures. The numbers are too small for any further analysis or to draw any reliable conclusions.

Table 3.E8 Indications for first data-linked revision after any primary elbow replacement. Acute trauma and elective cases are shown separately, for total elbow replacement, lateral resurfacing and distal humeral hemiarthroplasty, and radial head replacement.

Type of primary procedure		Number of primaries	Total revised	Indication for first revision procedure					
				Aseptic loosening	Failed hemi-arthroplasty	Infection	Instability	Other indication for revision	Peripros-thetic fracture
All acute trauma and elective cases		7,280	300	116	12	88	36	38	41
Acute trauma	Confirmed elbow replacements	3,544	71	23	5	19	11	14	5
	Total elbow replacement	857	31	12	0	14	<4	<4	5
	Total elbow replacement inc. radial head replacement	<4	0	0	0	0	0	0	0
	Radial head replacement	2,384	29	11	0	<4	6	10	0
	Lateral resurfacing	0	0	0	0	0	0	0	0
	Distal humeral hemiarthroplasty	301	11	0	5	<4	4	<4	0
	Unconfirmed elbow replacements	226	6	<4	<4	<4	<4	0	0
	Unconfirmed total elbow replacement	172	<4	<4	<4	0	<4	0	0
	Unconfirmed radial head replacement	44	<4	<4	0	0	<4	0	0
	Unconfirmed lateral resurfacing	<4	0	0	0	0	0	0	0
	Unconfirmed distal humeral hemiarthroplasty	9	<4	0	0	<4	0	0	0

Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form, or with no component data in the record, are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E8 (continued)

Type of primary procedure		Number of primaries	Total revised	Indication for first revision procedure					
				Aseptic loosening	Failed hemi-arthroplasty	Infection	Instability	Other indication for revision	Peripros-thetic fracture
Elective	**Confirmed elbow replacements**	**3,296**	**199**	**82**	**4**	**61**	**18**	**21**	**33**
	Total elbow replacement	2,693	166	72	0	58	12	12	30
	Total elbow replacement inc. radial head replacement	64	7	<4	0	<4	0	<4	<4
	Radial head replacement	477	21	7	<4	<4	4	6	0
	Lateral resurfacing	29	<4	0	0	0	0	<4	0
	Distal humeral hemiarthroplasty	33	<4	0	<4	0	<4	0	0
	Unconfirmed elbow replacements	**214**	**24**	**9**	**<4**	**7**	**4**	**<4**	**<4**
	Unconfirmed total elbow replacement	188	21	9	<4	7	<4	<4	<4
	Unconfirmed radial head replacement	11	0	0	0	0	0	0	0
	Unconfirmed lateral resurfacing	11	<4	0	0	0	<4	0	<4
	Unconfirmed distal humeral hemiarthroplasty	4	<4	0	0	0	0	<4	0

Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form, or with no component data in the record, are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

3.5.3 Mortality after primary elbow replacement surgery

For this analysis, the second procedure of a pair of bilateral operations performed on the same day were excluded (Figure 3.E1, page 229). Among the remaining 7,266 procedures, 873 of the recipients had died by the end of December 2021.

Table 3.E9 KM estimates of cumulative mortality (95% CI) by time from primary elbow replacement, for acute trauma and elective cases.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

		Number of primaries	Age (Median, IQR)	Male (%)	Time since primary										
					30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
All acute trauma and elective cases		**7,266**	**65 (53 to 74)**	**33**	**0.21 (0.13-0.34)**	**0.50 (0.36-0.69)**	**1.95 (1.65-2.31)**	**4.07 (3.62-4.58)**	**6.68 (6.08-7.35)**	**9.58 (8.82-10.40)**	**13.05 (12.11-14.06)**	**16.45 (15.34-17.64)**	**19.11 (17.84-20.46)**	**22.14 (20.62-23.74)**	**25.47 (23.46-27.62)**
Acute trauma	**All acute trauma cases**	**3,759**	**62 (48 to 74)**	**34**	**0.35 (0.20-0.60)**	**0.65 (0.44-0.97)**	**2.14 (1.71-2.68)**	**4.14 (3.51-4.88)**	**6.71 (5.85-7.68)**	**9.29 (8.22-10.49)**	**12.35 (11.02-13.82)**	**15.91 (14.29-17.71)**	**18.52 (16.64-20.57)**	**20.00 (17.91-22.30)**	*23.83 (20.76-27.27)*
	Total elbow replacement	856	77 (71 to 83)	17	0.94 (0.47-1.87)	2.01 (1.25-3.21)	6.12 (4.67-8.00)	11.05 (9.03-13.48)	17.29 (14.70-20.27)	23.70 (20.62-27.15)	29.75 (26.25-33.60)	*36.15 (32.23-40.39)*	*40.09 (35.84-44.65)*	*42.13 (37.60-46.99)*	*47.65 (41.10-54.67)*
	Total elbow replacement inc. radial head replacement	<4	75 (71 to 79)	0											
	Radial head replacement	2,374	53 (41 to 63)	42	0.13 (0.04-0.40)	0.17 (0.06-0.45)	0.59 (0.34-1.02)	1.16 (0.78-1.73)	1.54 (1.08-2.20)	2.38 (1.73-3.27)	3.42 (2.56-4.56)	5.14 (3.93-6.70)	6.87 (5.31-8.85)	*6.87 (5.31-8.85)*	*9.49 (6.85-13.09)*
	Distal humeral hemiarthroplasty	301	71 (64 to 79)	18	0.00 (.-.)	0.35 (0.05-2.47)	*2.01 (0.84-4.76)*	*5.33 (2.96-9.51)*	*8.97 (5.00-15.80)*						
	Unconfirmed total elbow replacement	172	75 (65 to 82.5)	22	*1.16 (0.29-4.57)*	*1.16 (0.29-4.57)*	*4.12 (1.99-8.45)*	*8.97 (5.50-14.44)*	*17.81 (12.73-24.62)*	*20.85 (15.26-28.12)*	*28.49 (21.61-36.99)*	*34.57 (26.37-44.43)*	*37.84 (29.02-48.28)*	*47.53 (36.39-60.11)*	
	Unconfirmed radial head replacement	44	55 (43.5 to 61.5)	41		*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*			
	Unconfirmed lateral resurfacing	<4	74 (74 to 74)	100											
	Unconfirmed distal humeral hemiarthroplasty	9	71 (61 to 77)	33											

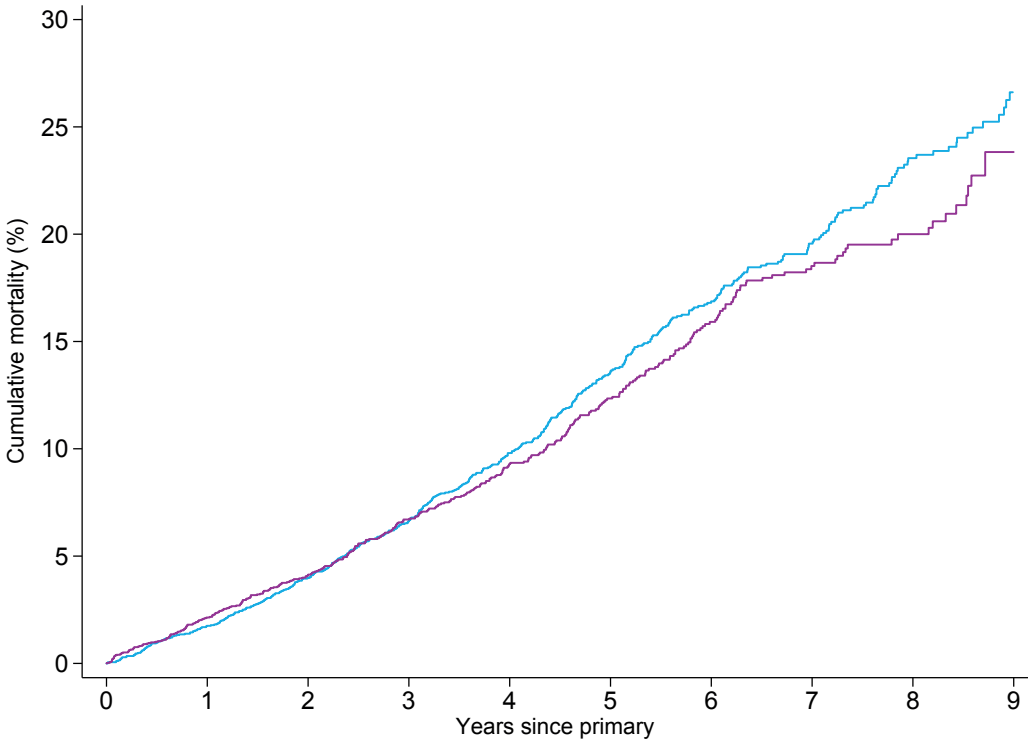
Note: Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time period.
Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form, or with no component data in the record, are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E9 (continued)

		Number of primaries	Age (Median, IQR)	Male (%)	Time since primary										
					30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
Elective	All elective cases	3,507	67 (57 to 75)	32	0.06 (0.01-0.23)	0.35 (0.20-0.61)	1.75 (1.36-2.26)	3.98 (3.36-4.72)	6.64 (5.82-7.59)	9.80 (8.76-10.96)	13.59 (12.31-15.00)	16.87 (15.38-18.50)	19.56 (17.87-21.39)	23.54 (21.48-25.77)	*26.61 (24.01-29.44)*
	Total elbow replacement	2,691	69 (60 to 76)	30	0.07 (0.02-0.30)	0.37 (0.20-0.70)	1.85 (1.40-2.45)	4.55 (3.80-5.45)	7.64 (6.64-8.78)	11.25 (10.00-12.65)	15.51 (13.98-17.20)	19.10 (17.33-21.03)	22.03 (20.03-24.20)	25.74 (23.35-28.33)	*29.45 (26.27-32.93)*
	Total elbow replacement inc. radial head replacement	64	64 (49.5 to 71.5)	36		*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*4.06 (1.03-15.29)*	*4.06 (1.03-15.29)*	*9.70 (3.69-24.18)*	*13.46 (5.65-30.19)*	*17.40 (7.93-35.71)*	*17.40 (7.93-35.71)*	
	Radial head replacement	476	52 (41 to 63)	47	0.00 (.-.)	0.00 (.-.)	0.92 (0.35-2.44)	1.18 (0.49-2.81)	1.47 (0.66-3.25)	*2.56 (1.32-4.95)*	*4.55 (2.59-7.94)*	*5.16 (2.99-8.84)*	*6.35 (3.58-11.12)*	*8.34 (4.42-15.44)*	*8.34 (4.42-15.44)*
	Lateral resurfacing	29	54 (43 to 61)	66				*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*0.00 (.-.)*	*7.69 (1.12-43.36)*
	Distal humeral hemiarthroplasty	33	73 (67 to 81)	21	*0.00 (.-.)*	*0.00 (.-.)*	*3.70 (0.53-23.51)*	*3.70 (0.53-23.51)*	*3.70 (0.53-23.51)*						
	Unconfirmed total elbow replacement	188	67 (57 to 75)	30		*1.06 (0.27-4.19)*	*3.21 (1.46-7.01)*	*4.86 (2.56-9.13)*	*7.15 (4.21-12.00)*	*10.15 (6.51-15.64)*	*12.08 (8.03-17.95)*	*16.24 (11.40-22.86)*	*18.07 (12.83-25.12)*	*27.73 (20.61-36.68)*	*29.15 (21.73-38.41)*
	Unconfirmed radial head replacement	11	65 (47 to 76)	27											
	Unconfirmed lateral resurfacing	11	59 (51 to 68)	36			*0.00 (.-.)*								
	Unconfirmed distal humeral hemiarthroplasty	4	71.5 (54 to 80.5)	25											

Note: Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time period.
Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form, or with no component data in the record, are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Figure 3.E9 KM estimates of cumulative mortality of primary elbow replacement by acute trauma and elective cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
Acute trauma	3,759	3,191	2,690	2,066	1,580	1,197	841	547	304	*105*
Elective	3,507	3,184	2,922	2,468	2,010	1,547	1,151	818	497	*196*

Figure 3.E9 shows the overall cumulative percentage probability of mortality shown separately for acute trauma and the elective cases and Table 3.E9 (page 251) shows cumulative percentage probability of mortality by procedure.

The overall mortality of acute trauma and elective procedures appears comparable in the first nine years after joint replacement. However, when the mortality rate is compared between procedure types it is clear that mortality is not comparable, for example: the mortality rate at four years after primary total elbow replacement for trauma is 110.7% higher than the rate in elective total elbow arthroplasty, with a four-year mortality rate of 23.7%.

3.5.4 Conclusions

The annual number of primary elbow replacement procedures entered into the registry has increased since 2012, other than in 2020 and 2021 which were profoundly affected by COVID-19. The NJR has one of the largest datasets of elbow replacement globally. This year, the volume of procedures was greatly enhanced through an audit of historical elbow replacement data.

The type of procedure reported is determined from two sources of information. The first is the procedure type recorded on the MDS data collection form by the surgeon, or their deputy, at the time of the procedure. The second source is the set of component labels attached to the MDS form and recorded at upload of the record. When there is a mismatch between these two sources, i.e. the components entered do not match the procedure type recorded or where there is no component data at all in the data entry record, the procedure type is reported as unconfirmed. Further work is required to reconcile these unconfirmed procedures and reduce the proportion of 'unconfirmed' cases. This will enhance the comprehensiveness and utility of the data moving forward.

Distal humeral hemiarthroplasty was not included in the MDS until June 2018. Despite this, its use appears to be increasing overall, but total numbers remain low, so it is not yet possible to compare the revision rates for this newer procedure against the data for total elbow replacement. Most distal humeral hemiarthroplasty and radial head replacement procedures are performed for acute trauma and trauma sequelae as expected.

The distribution of indications for elective total elbow replacement has been consistent over the last five years of data entry with inflammatory arthropathy accounting for 36.4% of cases. In 2021 there were 273 confirmed elective and acute trauma primary total elbow replacements (including seven with radial head replacements) performed in 104 units by 102 consultants. The volume of procedures does not show large variation, however the number of units performing elbow replacements has declined from 121 in 2019 and the number of consultants from 143 in 2019. It has been the intention of the NHSE/I GIRFT programme to centralise total elbow replacement surgery across fewer specialist centres so this data is encouraging, although this comparison may have been affected by the impact of COVID-19 on the 2020 and 2021 figures. It should be noted that the median numbers of primary procedures per unit and per surgeon have not changed significantly from 2019 to those reported in 2021.

The Kaplan-Meier estimate of cumulative revision of total elbow replacement at four years was 3.89% (95% CI 2.65-5.72) for trauma patients and 6.16% (95% CI 5.22-7.27) for elective cases. Disparities in the rate of revision were observed between implant brands. Brand comparisons will become more evident and reliable as the size of the elbow cohort increases over time. We note that the main indications for revision were infection and aseptic loosening, and this is observed for both acute trauma and elective cases.

The five-year mortality rate for elbow replacement in all cases is 13.05% (95% CI 12.11-14.06) with differences seen between trauma and elective surgery. The one-year mortality rate following total elbow replacement remains higher in the trauma patient population than in those having elective surgery, however this is likely to represent a difference in the demographics of these two patient groups.

NJR Elbow Audit

The NJR Data Audit Committee in collaboration with the British Orthopaedic Trainees Association, British Elbow and Shoulder Society, Royal College of Surgeons of England and the British Orthopaedic Association has undertaken a detailed audit of NJR and HES datasets with verification against source hospital records to improve the completeness and accuracy of the elbow replacement database.

We are thankful for the support of BOTA, BESS, RCS of England and the BOA in the work on this audit and offer our particular thanks to Professor Adam Watts who led the work; also to Zaid Hamoodi, NW trainee, Jo Shapiro from NEC, and Becky Swinson of the NJR Management Team, for their dedicated approach to ensuring the success of the audit.

The NJR would like to thank the following contributors including orthopaedic consultants, trainees and hospital data managers for their hard work to improve the elbow dataset:

Jennifer Abbott, Philip Ahrens, Majedal Al-Najjar, Rouin Amirfeyz, Sudhi Ankarath, Fiona Ashton, Kelly Aulton, Jane Austin, Rish Bahia, Steven Baines, Marisol Baldomir, Benjamin Barkham, Lucy Barnes, Emily Barrett, Timothy Batten, Luckshman Bavan, Gev Bhabra, Ankit Bhatt, Samuel Bingham, Jenny Blastland, David Boardman, Khalis Boksh, Lesley Boulton, Linda Brannan, Zarina Breidaka, Rachel Brereton, Mark Brinsden, Joanne Brooker, Sabine Brookes, Cheryl Broux, Jacqueline Browne, Karen Burnett, Usman Butt, Barry Campaner, Somashree Chatterji, Adrian Chojnowski, Janani Cittambalam, Ben Clarke, Malgorzata (Gosia) Clarke, Andrew Clelland, Roz Cochrane, Karen Colbridge, Elizabeth Correa, Jason Crawford, Sherri Curtis, Rory Cuthbert, Lisa Dale, Sammy Davies, Joanne Davis, Sonu Dennis, Aravind Desai, Ronald Dodenhoff, Peter Domos, Steven Drew, Jefin Edakalathur, Michelle Edwards, Colin Esler, Jon Evans, Muhamed Farhan-Alanie, Simon Federer, Sharon Ferdinandus, Marie Finch, Christine Forde, Lisa Fowler, Marieta Franklin, Hamez Gacaferi, David Gamble, Vicki Gill, Jean Ginley, Emma Glancey, Gemma Glanville, Karen Goddard, Carly Goldsmith, Fiona Goodwin, Benjamin Goring, Paul Guyver, Thomas Hardley, Louise Harnett, Joanna Harris, Dave Hawkes, Stuart Hay, Susan Hickey, Anne Hickinson, Maria Hitchcock, Terry Holdcroft, Hazel Hughes, Rabia Imtiaz, Yamen Jabr, Crystal Jackson, Jackie Jameson, Odette Jayme, Andreea Jimenez, Adrian Jones, Jadranka Jovanovic, Vanessa Kabala, Niel Kang, Gaynor Kelly, Jonathan Kent, M Kent, Carla Kerr, Christina King, Gemma Kinsley, Jacqueline Kord, Sachin Kumar, Alexandria Lewin, Rachel Mahoney, Sheraz Malik, Alexandros Maris, Michael Markey, Christy Martin, Amy McGowan, Nicolee Mckeown, Debbie McNally, Joel Melton, Jane Miller, Cathy Millyard, Claire Mitchell, Darren Munn, Rajesh Nanda, Aly Nicholl, Jessica Nightingale, Peter Orton, Kelly Page, Maria Paius, Chris Peach, Sue Penfold, Eleanore Phillips, Craig Pole, Ganesh Prasad, Julie Pride, Ajay Radhakrishnan, Ashwanth Ramesh, Adil Rashid, Damir Rasidovic, Emily Ratford, Lee Van Rensburg, Jae Rhee, Martha Ricketts, Samantha Rodgers, Aaron Rooney, Dan Rossouw, David Samy, Kelly Sanderson, Dilraj Sandher, Mark Saunders, Nicky Saunders, Kim Savage, Seif Sawalha, Melissa Schouw, Sohan Shah, Shantanu Shahane, Grant Shaw, Sijin Sidharthan, Vera Simpson, Harvinder Singh, Apurv Sinha, Christopher Smith, Kerry Smith, Muhab Soufan, Cynthia Southgate, Jeremy Southgate, Nicola Spearpoint, Rebecca Stainer, Batya Stimler, Andrew Stone, Danielle Suter, Tareq Tareef, Kanthan Theivendran, Andrew Thompson, Jackie Thompson, Michael Townley, Jennie Truman, Rob Turner, Sam Vollans, Louise Waller, Eve Robertson Waters, Nicholas Wei, William James White, Mark Wilkinson, Daniel Williams, Philip Williams, Stephanie Wilson, David Wood, Tejas Yarashi.

For ongoing information on NJR Elbow Audit and contributors please click here

3.6 Outcomes after shoulder replacement

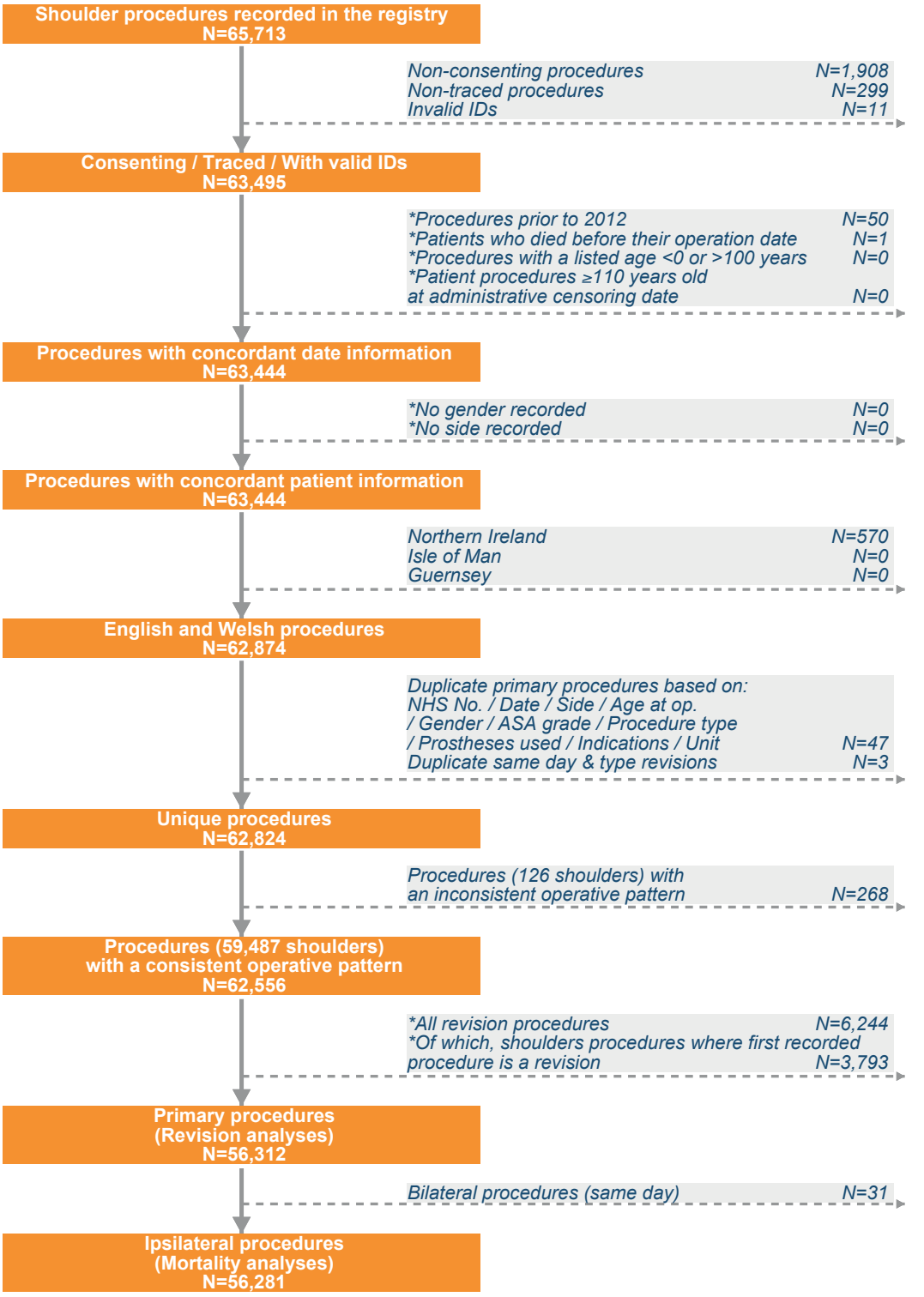
3.6.1 Overview of primary shoulder replacement surgery

Shoulder replacements have been recorded in the registry since 2012. In this section we address an overview of the (data linked) primary shoulder replacements performed up to 31 December 2021 and also document the first revision and mortality, when these events had occurred following a primary shoulder replacement.

In 2018 and 2019 a rigorous review of the shoulder data was undertaken due to the rapid expansion of shoulder implant types available. As a consequence of this review, new classifications and component attributes are now used within the report to define the primary groupings throughout the whole of this section. The report has now moved to whole construct validation, ensuring all relevant elements required to build a construct are present in a procedure. We have cross-checked the implanted construct with the indicated procedure at the time of the surgery and positively confirmed the implanted construct matches the reported procedure. This has led to the definition of unconfirmed constructs of which there are either insufficient implants listed to make up a complete construct, or the implants used do not match the indicated procedure. A total of 5,586 (9.9%) procedures are unconfirmed; although the volume is expected to improve in future reports, with the development of more rigorous checks.

We define a stemmed humeral component as a humeral component in which any part enters the humeral diaphysis, while a stemless humeral component is defined as being completely confined to the metaphysis with no part entering the diaphysis.

Figure 3.S1 Shoulder cohort flow diagram.



A total of 56,312 primary shoulder replacements were available for our analysis in a total of 51,617 patients. Of these patients, 4,695 had documented replacements on both left and right sides, 31 of which were bilateral simultaneous operations (left and right on the same day). See Figure 3.S1 (page 258) for a detailed description of patients included in this section.

Table 3.S1 Number and percentage of primary shoulder replacements (elective or acute trauma), by year and type of shoulder replacement.

	All years N (%)	Year of primary									
		2012 N (%)	2013 N (%)	2014 N (%)	2015 N (%)	2016 N (%)	2017 N (%)	2018 N (%)	2019 N (%)	2020 N (%)	2021 N (%)
All cases	**56,312 (100.0)**	**2,556 (100.0)**	**4,422 (100.0)**	**5,317 (100.0)**	**5,744 (100.0)**	**6,538 (100.0)**	**7,009 (100.0)**	**7,261 (100.0)**	**7,804 (100.0)**	**4,132 (100.0)**	**5,529 (100.0)**
Proximal humeral hemiarthroplasty	**8,508 (15.1)**	**894 (35.0)**	**1,312 (29.7)**	**1,291 (24.3)**	**1,066 (18.6)**	**1,015 (15.5)**	**840 (12.0)**	**707 (9.7)**	**684 (8.8)**	**324 (7.8)**	**375 (6.8)**
Resurfacing	2,989 (5.3)	481 (18.8)	600 (13.6)	538 (10.1)	377 (6.6)	368 (5.6)	221 (3.2)	147 (2.0)	131 (1.7)	64 (1.5)	62 (1.1)
Stemless	1,301 (2.3)	69 (2.7)	133 (3.0)	165 (3.1)	140 (2.4)	164 (2.5)	171 (2.4)	176 (2.4)	168 (2.2)	51 (1.2)	64 (1.2)
Stemmed	4,218 (7.5)	344 (13.5)	579 (13.1)	588 (11.1)	549 (9.6)	483 (7.4)	448 (6.4)	384 (5.3)	385 (4.9)	209 (5.1)	249 (4.5)
Total shoulder replacement	**15,103 (26.8)**	**631 (24.7)**	**1,178 (26.6)**	**1,536 (28.9)**	**1,771 (30.8)**	**1,899 (29.0)**	**1,984 (28.3)**	**1,901 (26.2)**	**1,956 (25.1)**	**984 (23.8)**	**1,263 (22.8)**
Resurfacing	487 (0.9)	49 (1.9)	99 (2.2)	82 (1.5)	88 (1.5)	78 (1.2)	45 (0.6)	24 (0.3)	15 (0.2)	6 (0.1)	<4 (<0.1)
Stemless	5,606 (10.0)	137 (5.4)	256 (5.8)	390 (7.3)	504 (8.8)	632 (9.7)	733 (10.5)	855 (11.8)	950 (12.2)	511 (12.4)	638 (11.5)
Stemmed	9,010 (16.0)	445 (17.4)	823 (18.6)	1,064 (20.0)	1,179 (20.5)	1,189 (18.2)	1,206 (17.2)	1,022 (14.1)	991 (12.7)	467 (11.3)	624 (11.3)
Reverse polarity total shoulder replacement	**27,110 (48.1)**	**687 (26.9)**	**1,351 (30.6)**	**1,908 (35.9)**	**2,330 (40.6)**	**3,009 (46.0)**	**3,611 (51.5)**	**3,987 (54.9)**	**4,606 (59.0)**	**2,432 (58.9)**	**3,189 (57.7)**
Stemless	232 (0.4)	5 (0.2)	14 (0.3)	15 (0.3)	25 (0.4)	25 (0.4)	21 (0.3)	38 (0.5)	23 (0.3)	19 (0.5)	47 (0.9)
Stemmed	26,878 (47.7)	682 (26.7)	1,337 (30.2)	1,893 (35.6)	2,305 (40.1)	2,984 (45.6)	3,590 (51.2)	3,949 (54.4)	4,583 (58.7)	2,413 (58.4)	3,142 (56.8)
Interpositional arthroplasty	**5 (<0.1)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**<4 (<0.1)**	**<4 (<0.1)**	**0 (0)**	**0 (0)**
Unconfirmed	**5,586 (9.9)**	**344 (13.5)**	**581 (13.1)**	**582 (10.9)**	**577 (10.0)**	**615 (9.4)**	**574 (8.2)**	**664 (9.1)**	**555 (7.1)**	**392 (9.5)**	**702 (12.7)**
Unconfirmed HHA	387 (0.7)	22 (0.9)	59 (1.3)	40 (0.8)	42 (0.7)	40 (0.6)	34 (0.5)	46 (0.6)	46 (0.6)	28 (0.7)	30 (0.5)
Unconfirmed TSR	1,967 (3.5)	202 (7.9)	312 (7.1)	305 (5.7)	258 (4.5)	269 (4.1)	205 (2.9)	172 (2.4)	82 (1.1)	67 (1.6)	95 (1.7)
Unconfirmed RTSR	3,225 (5.7)	120 (4.7)	210 (4.7)	237 (4.5)	277 (4.8)	306 (4.7)	335 (4.8)	442 (6.1)	426 (5.5)	297 (7.2)	575 (10.4)
Unconfirmed IPA	7 (<0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (0.1)	<4 (<0.1)	0 (0)	<4 (<0.1)

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S1 (page 259) illustrates the number of shoulder replacements and how they have changed across time. There is a steady increase in the number of primary shoulder replacements year-on-year until the impact of COVID in 2020. It also illustrates relative proportions of proximal humeral hemiarthroplasty (HHA), conventional total shoulder replacement (TSR) and reverse polarity total shoulder replacement (RTSR). There was a continued increasing preference for reverse polarity total shoulder replacement year-on-year until 2019 which has since plateaued, although it is not clear if this is a true plateau or a secondary effect of the impact of COVID.

The number of unconfirmed procedures contained within the registry is illustrated. Using more evolved methods of construct and procedure cross-validation, procedures with insufficient prostheses elements to build a unique construct or a construct that disagrees with the procedure indicated at the time of surgery are identified. It is noted that entering all the elements of reverse polarity total shoulder replacements appears to be particularly challenging and so it is urged that those completing the data entry forms and entering data should pay particular attention to these procedures.

Figure 3.S2 and Figure 3.S3 (pages 261 and 262) show the yearly number of primary shoulder replacements performed for elective and acute trauma indications respectively. Elective and acute trauma procedures have been stratified by procedure type. Please note the difference in scale of the y-axis between each sub-plot. Each bar is further stratified by the volume of procedures that the surgeon conducted in that year across both elective and acute trauma settings i.e. if a surgeon performed 24 elective primary stemmed humeral hemiarthroplasty procedures and 24 acute stemmed humeral hemiarthroplasty procedures their annual total volume would be 48 procedures. Those 48 procedures would contribute to the grey sub-division in both elective and acute trauma figures.

Figure 3.S2 shows a complex pattern of increasing and decreasing treatment preferences for elective primary replacement. Resurfacing humeral hemiarthroplasty and resurfacing total shoulder replacements have declined since the start of data collection, stemless total shoulder replacements have steadily increased, the volume of stemmed reverse polarity total shoulder replacement has increased substantially. Stemmed humeral hemiarthroplasty has decreased while stemmed total shoulder replacements have also fallen more recently, although that trend seems to have started prior to the impact of COVID in 2020 and 2021. In the more common procedures (stemless total shoulder replacements, and stemmed reverse polarity total shoulder replacements), the growth in procedures appears to be occurring in higher volume shoulder surgeons.

For primary replacement for acute trauma, Figure 3.S3 shows the popularity of stemmed humeral hemiarthroplasty has reduced in recent years while the popularity of stemmed reverse polarity total shoulder replacements continues to steadily increase allowing for the impact of COVID in 2020 and 2021. Stemmed reverse polarity total shoulder replacements are increasingly conducted by higher volume surgeons.

Figure 3.S2 Frequency of primary shoulder replacements within elective patients stratified by procedure type, bars stacked by volume per consultant per year.

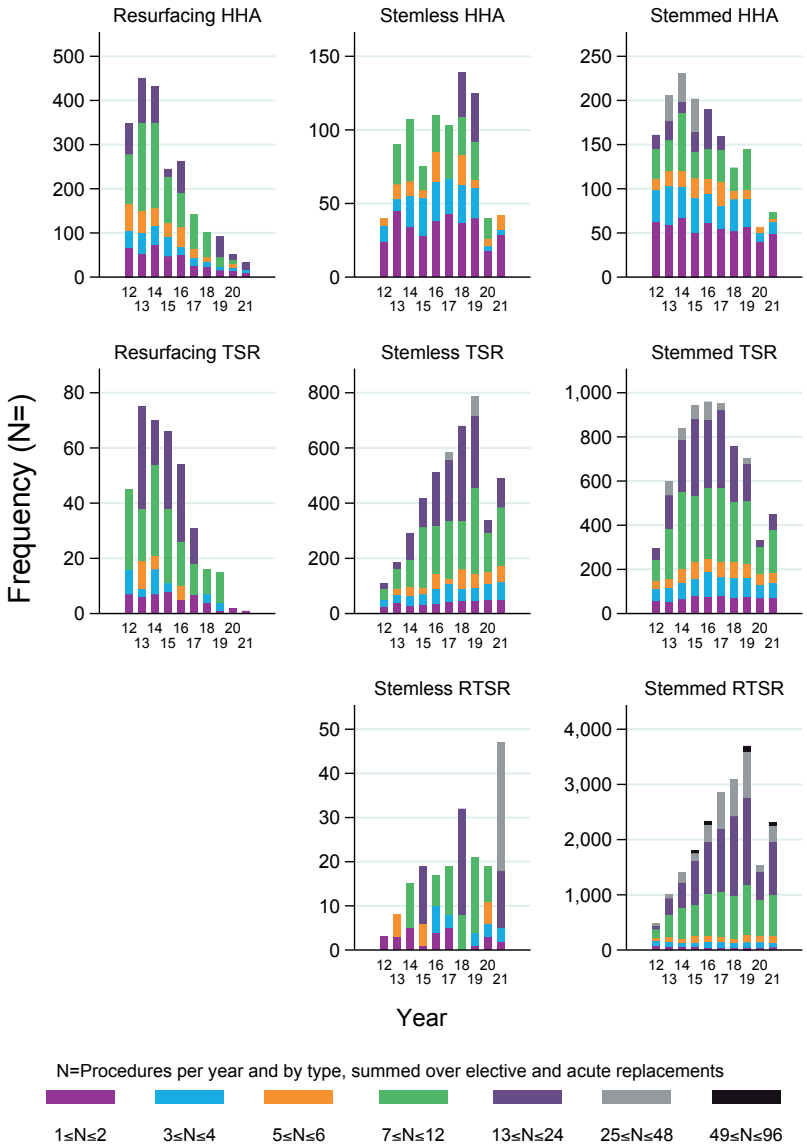


Figure 3.S3 Frequency of primary shoulder replacements within acute trauma patients stratified by procedure type, bars stacked by volume per consultant per year.

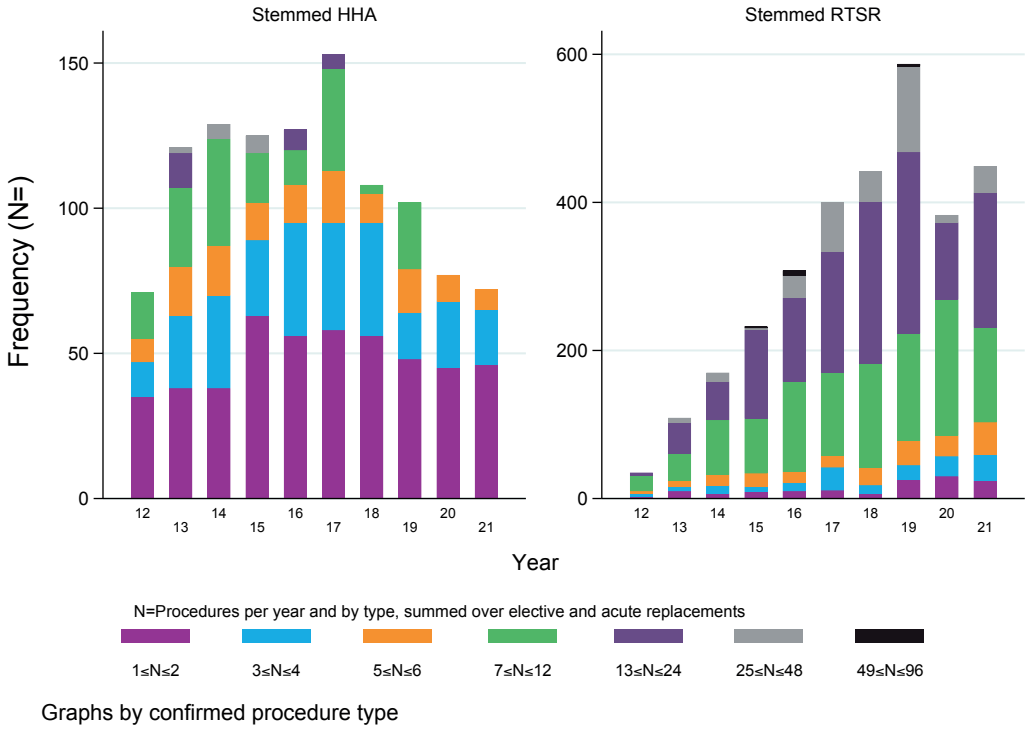


Figure 3.S4 Age (Box and Whisker plot*) and frequency of primary shoulder replacements by gender and type of shoulder replacement.

*| represents the median, boxes represent lower and upper interquartile range, whiskers represent the 2.5th and 97.5th centile of the distribution.

Figure 3.S4 illustrates the age and gender difference between the different types and sub-types of shoulder replacements using a modified 'box and whisker' plot. The whiskers represent the 2.5th and 97.5th centile of the distribution. The figure also shows the frequency of procedures by gender and procedure type. The plots illustrate the points that females tend to be older than males at the time of operation and those receiving reverse polarity total shoulder replacements tend to be older than those receiving proximal humeral hemiarthroplasty or conventional total shoulder replacements. Figure 3.S4 also illustrates that the majority of procedures recorded within the registry are reverse polarity total shoulder replacements. It also clearly illustrates that the majority of unconfirmed procedures consist of reverse polarity total shoulder replacements.

Table 3.S2 Demographic characteristics of patients undergoing primary shoulder replacements, by acute or elective indications and type of shoulder replacement.

	Shoulder type	Number of cases	Male N (%)	Age in years at primary median (IQR*) range**
Acute trauma	All cases	6,108	1,412 (23.1)	73 (67 to 79) 27 to 99
	Proximal humeral hemiarthroplasty	1,812	554 (30.6)	68 (59 to 76) 27 to 96
	Total shoulder replacement	15	9 (60.0)	68 (53 to 74) 43 to 79
	Reverse polarity total shoulder replacement	3,614	701 (19.4)	75 (70 to 80) 48 to 99
	Interpositional arthroplasty	0	0 (0.0)	0 (0 to 0) 0 to 0
	Unconfirmed	667	148 (22.2)	73 (67 to 79) 30 to 95
Elective	All cases	50,204	15,438 (30.8)	73 (67 to 79) 17 to 100
	Proximal humeral hemiarthroplasty	6,696	2,255 (33.7)	70 (61 to 77) 17 to 95
	Resurfacing	2,983	920 (30.8)	71 (63 to 78) 20 to 95
	Stemless	1,291	553 (42.8)	67 (56 to 75) 17 to 93
	Stemmed	2,422	782 (32.3)	70 (60 to 78) 19 to 95
	Total shoulder replacement	15,088	4,796 (31.8)	70 (63 to 75) 18 to 99
	Resurfacing	487	140 (28.7)	71 (63 to 76) 29 to 95
	Stemless	5,602	2,020 (36.1)	69 (62 to 75) 18 to 99
	Stemmed	8,999	2,636 (29.3)	71 (65 to 76) 24 to 96
	Reverse polarity total shoulder replacement	23,496	6,795 (28.9)	76 (71 to 80) 17 to 100
	Stemless	232	84 (36.2)	74 (70 to 78) 49 to 89
	Stemmed	23,264	6,711 (28.8)	76 (71 to 80) 17 to 100
	Interpositional arthroplasty	5	<4 (60.0)	58 (55 to 68) 42 to 73
	Unconfirmed	4,919	1,589 (32.3)	73 (66 to 78) 18 to 96
	Unconfirmed HHA	317	115 (36.3)	69 (58 to 75) 18 to 92
	Unconfirmed TSR	1,922	695 (36.2)	69 (61 to 76) 20 to 96
	Unconfirmed RTSR	2,675	776 (29.0)	75 (69 to 80) 18 to 95
	Unconfirmed IPA	5	<4 (60.0)	64 (60 to 65) 58 to 79

*IQR: Interquartile range, i.e. 25th and 75th centile.
**Range: Lowest and highest observed values.
Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S2 displays similar information to Figure 3.S4 (page 263), except results are divided by acute trauma and elective procedures.

Table 3.S3 Numbers of units and consultant surgeons providing primary shoulder replacements and median and interquartile range of procedures performed by unit and consultant, by year, last five years and overall.

Year of primary	Primary replacements N	Units providing primary replacements in each year N	Primary replacements per unit median (IQR)	Consultants providing primary replacements in each year N	Primary replacements per consultant median (IQR)
All years	56,312	415	89 (33 to 194)	925	20 (2 to 91)
Last 5 years	31,735	401	54 (23 to 113)	698	26.5 (4 to 71)
2012	2,556	263	6 (3 to 12)	380	4 (2 to 9)
2013	4,422	312	9 (4 to 18)	432	7 (2 to 15)
2014	5,317	338	10 (4 to 21)	456	8 (3 to 17)
2015	5,744	347	11 (4 to 23)	485	8 (3 to 17)
2016	6,538	348	14 (5 to 26)	491	10 (4 to 19)
2017	7,009	364	14 (5 to 27)	492	11 (5 to 21)
2018	7,261	368	14 (5 to 28)	508	11 (4 to 21)
2019	7,804	374	14 (6 to 29)	518	11 (5 to 22)
2020	4,132	358	8 (4 to 15)	482	7 (3 to 12)
2021	5,529	366	11 (5 to 21)	492	9 (3 to 17)

Table 3.S3 illustrates the number of primary shoulder replacements and the number of units and consultants conducting shoulder replacements within the registry. The table also illustrates the median and interquartile range of the number of replacements performed within each unit or by each consultant. This is displayed overall, aggregated by the last five years of data, and by year of data collection. The results illustrate that the median, and interquartile range, number of procedures performed by units and consultants has remained static for the last few years, with the exception of 2020 and 2021, where due to COVID-19 it reduced and now stands at 11 (5 to 21) and 9 (3 to 17) procedures respectively.

Table 3.S4 Number and percentage of primary shoulder replacements by indication and type of shoulder replacement.

	Acute trauma	Elective							
			N (%)* for each indication in elective procedures only						
	Number of cases N (%)	Number of cases N (%)	Osteoarthritis	Cuff tear arthropathy	Trauma sequelae	Other inflamatory arthropathy	Avascular necrosis	Other causes***	Cuff tear without arthropathy**
All cases	6,108 (100.0)	50,204 (100.0)	30,416 (100.0)	13,848 (100.0)	3,563 (100.0)	1,964 (100.0)	1,621 (100.0)	1,193 (100.0)	767 (100.0)
Proximal humeral hemiarthroplasty	**1,812 (29.7)**	**6,696 (13.3)**	**5,005 (16.5)**	**358 (2.6)**	**589 (16.5)**	**405 (20.6)**	**554 (34.2)**	**198 (16.6)**	**9 (1.2)**
Resurfacing	6 (0.1)	2,983 (5.9)	2,539 (8.3)	167 (1.2)	71 (2.0)	165 (8.4)	107 (6.6)	52 (4.4)	<4 (0.3)
Stemless	10 (0.2)	1,291 (2.6)	1,041 (3.4)	18 (0.1)	85 (2.4)	64 (3.3)	131 (8.1)	39 (3.3)	0 (0)
Stemmed	1,796 (29.4)	2,422 (4.8)	1,425 (4.7)	173 (1.2)	433 (12.2)	176 (9.0)	316 (19.5)	107 (9.0)	7 (0.9)
Total shoulder replacement	**15 (0.2)**	**15,088 (30.1)**	**14,038 (46.2)**	**35 (0.3)**	**304 (8.5)**	**525 (26.7)**	**389 (24.0)**	**195 (16.3)**	**5 (0.7)**
Resurfacing	0 (0)	487 (1.0)	465 (1.5)	0 (0)	4 (0.1)	22 (1.1)	<4 (0.1)	4 (0.3)	0 (0)
Stemless	4 (0.1)	5,602 (11.2)	5,190 (17.1)	11 (0.1)	121 (3.4)	199 (10.1)	131 (8.1)	96 (8.0)	<4 (0.3)
Stemmed	11 (0.2)	8,999 (17.9)	8,383 (27.6)	24 (0.2)	179 (5.0)	304 (15.5)	256 (15.8)	95 (8.0)	<4 (0.4)
Reverse polarity total shoulder replacement	**3,614 (59.2)**	**23,496 (46.8)**	**8,667 (28.5)**	**12,037 (86.9)**	**2,227 (62.5)**	**806 (41.0)**	**525 (32.4)**	**559 (46.9)**	**694 (90.5)**
Stemless	0 (0)	232 (0.5)	92 (0.3)	123 (0.9)	8 (0.2)	<4 (0.1)	4 (0.2)	<4 (0.2)	11 (1.4)
Stemmed	3,614 (59.2)	23,264 (46.3)	8,575 (28.2)	11,914 (86.0)	2,219 (62.3)	804 (40.9)	521 (32.1)	557 (46.7)	683 (89.0)
Interpositional arthroplasty	**0 (0)**	**5 (<0.1)**	**5 (<0.1)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**
Unconfirmed	**667 (10.9)**	**4,919 (9.8)**	**2,701 (8.9)**	**1,418 (10.2)**	**443 (12.4)**	**228 (11.6)**	**153 (9.4)**	**241 (20.2)**	**59 (7.7)**
Unconfirmed HHA	70 (1.1)	317 (0.6)	186 (0.6)	50 (0.4)	32 (0.9)	16 (0.8)	28 (1.7)	29 (2.4)	<4 (0.3)
Unconfirmed TSR	45 (0.7)	1,922 (3.8)	1,549 (5.1)	130 (0.9)	82 (2.3)	84 (4.3)	52 (3.2)	98 (8.2)	<4 (0.1)
Unconfirmed RTSR	550 (9.0)	2,675 (5.3)	963 (3.2)	1,238 (8.9)	327 (9.2)	128 (6.5)	73 (4.5)	114 (9.6)	56 (7.3)
Unconfirmed IPA	<4 (<0.1)	5 (<0.1)	<4 (<0.1)	0 (0)	<4 (0.1)	0 (0)	0 (0)	0 (0)	0 (0)

*Percentages are based on the total number of elective cases; please note the listed reasons are not mutually exclusive as more than one reason could have been stated.
**Only recorded in MDSv7 introduced in June 2018. Total cases recorded using MDSv7 =22,284.
***Includes 94 metastatic cancer/malignancies documented since MDSv6 (N=46,296), together with 255 dislocations documented since MDSv7 (N=22,284).
Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S4 (page 266) illustrates the number and percentage of primary shoulder procedures by the type and sub-type of shoulder replacement for both acute trauma and elective procedures. The indication for surgery in elective procedures is also illustrated. The majority of proximal humeral hemiarthroplasty and conventional total shoulder replacement procedures recorded in the registry are for an indication of osteoarthritis, whereas cuff tear arthropathy is the predominant indication for reverse polarity total shoulder replacements. It is important to note that the indications for surgery recorded in the registry are not mutually exclusive; 84.2% of procedures list a single indication for the cause of surgery with the remainder recording more than one indication.

Table 3.S5 (a) Number of resurfacing proximal humeral hemiarthroplasty replacements between 2012 and 2021 and within the last year by brand construct.

			Primary operations all years			Primary operations in 2021		
	Manufacturer(s)	Shoulder construct	All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Resurfacing HHA	Wright	Aequalis Resurfacing[HH.Resurf]	254	0	254	0	0	0
	FH	Arrow[HH.Resurf]	35	0	35	0	0	0
	Zimmer Biomet	Copeland[HH.Resurf]	1,669	<4	1,666	34	0	34
	DePuy	Epoca[HH.Resurf]	112	<4	111	0	0	0
	Exactech	Equinoxe[HH.Resurf:H.RPeg]	54	0	54	10	0	10
	DePuy	Global CAP[HH.Resurf]	624	<4	622	14	0	14
	Lima	SMR[HH.Resurf:H.RPeg]	110	0	110	0	0	0
	Lima	SMR[HH.Resurf]	23	0	23	0	0	0
	JRI	Vaios[HH.Resurf]	104	0	104	4	0	4

Table 3.S5 (b) Number of stemless proximal humeral hemiarthroplasty replacements between 2012 and 2021 and within the last year by brand construct.

			Primary operations all years			Primary operations in 2021		
	Manufacturer(s)	Shoulder construct	All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemless HHA	Zimmer Biomet	Versa-Dial[HH.Stand]: Nano[H. Stemless]	58	<4	57	<4	0	<4
	Mathys	Affinis[HH.Stand:H.Stemless]	626	5	621	37	0	37
	Arthrex	Eclipse[HH.Stand:H.Stemless]	136	<4	135	8	0	8
	DePuy	Global ICON[HH.Stand:H. Stemless]	21	0	21	0	0	0
	Lima	SMR[HH.Stand:H.Stemless]	31	0	31	<4	0	<4
	Zimmer Biomet	Sidus[HH.Stand:H.Stemless]	182	<4	181	9	0	9
	Wright	Simpliciti[HH.Stand:H.Stemless]	169	0	169	7	0	7
	Zimmer Biomet	TESS[HH.Stand:H.Stemless]	75	<4	73	0	0	0

The notes below apply to the tables on the following pages.

Note: HH.=Humeral head, H.=Humerus, G.=Glenoid, Resurf=Resurfacing, RPeg=Resurfacing peg, Ana=Anatomic, BP=Baseplate, Peg=Peg, Stand=Standard, Lin=Liner, Sph=Sphere, RevBear=Reverse bearing, Stand=Standard, NeckBody=Modular neck body, Mod=Modular Stem, MBStem=Monobloc stem, Dia=Diaphyseal stem, RevBear=Reverse bearing, RevCup=Reverse cup.
Note: Data are sorted by the brand of the humeral component.

Table 3.S5 (c) Number of stemmed proximal humeral hemiarthroplasty replacements between 2012 and 2021 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed HHA	Wright	Aequalis[HH.Stand]: Aequalis-Fracture[H.Standard]	236	202	34	7	6	<4
	Zimmer Biomet	Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	22	<4	19	0	0	0
	Wright	Aequalis[HH.Stand]: Ascend Flex[H.Standard]	288	6	282	40	0	40
	Zimmer Biomet	Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	155	8	147	9	0	9
	Zimmer Biomet	Bio-Modular[HH.Stand]: Comprehensive Fracture[H.Standard]	19	15	4	0	0	0
	Zimmer Biomet	Versa-Dial[HH.Stand]: Comprehensive Fracture[H.Standard]	207	167	40	20	18	<4
	DePuy	Global Unite[HH.Stand]: Global AP[H.Mod]	10	0	10	0	0	0
	DePuy	Global Advantage[HH.Stand]: Global FX[H.Standard]	217	174	43	4	<4	<4
	Zimmer Biomet	Bigliani/Flatow[HH.Stand]: TM[H.Dia]	24	<4	23	0	0	0
	Wright	Aequalis[HH.Stand:H.Standard]	197	4	193	0	0	0
	Mathys	Affinis[HH.Stand:H.Standard]	69	<4	66	<4	0	<4
	Mathys	Affinis[HH.Stand:H.NeckBody:H.Dia]	224	190	34	16	15	<4
	Zimmer Biomet	Anatomical[HH.Stand:H.Mod]	22	<4	20	0	0	0
	Zimmer Biomet	Anatomical Fracture[HH.Stand:H.Mod]	46	35	11	0	0	0
	FH	Arrow[HH.Stand:H.Standard]	33	5	28	0	0	0
	Wright	Ascend Flex[HH.Stand:H.Standard]	184	11	173	18	4	14
	Zimmer Biomet	Bigliani/Flatow[HH.Stand:H.Dia]	47	12	35	0	0	0
	Zimmer Biomet	Bio-Modular[HH.Stand:H.Standard]	11	6	5	0	0	0
	DePuy	Delta Xtend[HH.Stand:H.Standard]	41	<4	39	0	0	0
	DePuy	Epoca[HH.Stand:H.Mod]	115	51	64	0	0	0
	Exactech	Equinoxe[HH.Stand:H.Mod]	135	5	130	9	<4	8
	Exactech	Equinoxe[HH.Stand:H.Standard]	268	230	38	42	37	5
	DePuy	Global AP[HH.Stand:H.Mod]	253	6	247	<4	<4	0
	DePuy	Global Advantage[HH.Stand:H.Standard]	331	71	260	8	<4	5
	DePuy	Global Unite[HH.Stand:H.Mod]	29	17	12	0	0	0
	DePuy	Global Unite[HH.Stand:H.NeckBody:H.Mod]	359	273	86	34	30	4
	Smith & Nephew	Neer[H.MBStem]	24	8	16	0	0	0
	Zimmer Biomet	Nottingham[HH.Stand:H.Standard]	38	18	20	0	0	0
	Corin	Oxford[HH.Stand:H.Standard]	82	5	77	0	0	0
	Lima	SMR[HH.Stand:H.NeckBody:H.Dia]	325	179	146	30	17	13
	Lima	SMR[HH.Stand:H.Dia]	12	7	5	0	0	0
	JRI	Vaios[HH.Stand:H.NeckBody:H.Dia]	90	46	44	4	<4	<4

Table 3.S5 (d) Number of resurfacing total shoulder replacement replacements between 2012 and 2021 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Resurfacing TSR	Wright	Aequalis[G.Ana]: Aequalis Resurfacing[HH.Resurf]	25	0	25	0	0	0
	Wright	Aequalis Perform+[G.Ana]: Aequalis Resurfacing[HH.Resurf]	14	0	14	0	0	0
	FH	Arrow[G.Ana:HH.Resurf]	15	0	15	0	0	0
	DePuy	Epoca[G.BP:G.Ana:HH.Resurf]	204	0	204	0	0	0
	DePuy	Epoca[G.Peg:G.Ana:HH.Resurf]	54	0	54	0	0	0
	DePuy	Epoca[G.Ana:HH.Resurf]	126	0	126	0	0	0
	Exactech	Equinoxe[G.Ana:HH.Resurf:H.RPeg]	32	0	32	<4	0	<4

Table 3.S5 (e) Number of stemless conventional total shoulder replacement replacements between 2012 and 2021 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemless TSR	DePuy:Mathys	Epoca[G.BP]: Epoca[G.Ana]: Affinis[HH.Stand]: Affinis[H.Stemless]	39	0	39	0	0	0
	Arthrex:DePuy	Epoca[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	16	0	16	0	0	0
	Arthrex:Wright	Aequalis[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	77	0	77	0	0	0
	Arthrex:DePuy	Epoca[G.BP]: Epoca[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	51	0	51	0	0	0
	Arthrex	Universal[G.BP]: Universal[G.Lin]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	74	0	74	11	0	11
	Arthrex	Univers II[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	484	0	484	55	0	55
	Arthrex:DePuy	Global Anchor Peg[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	11	0	11	0	0	0
	Arthrex:DePuy	Epoca[G.Peg]: Epoca[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	15	0	15	0	0	0
	DePuy	Global Anchor Peg[G.Ana]: Global ICON[HH.Stand]: Global ICON[H.Stemless]	310	0	310	71	0	71
	DePuy	Global[G.Ana]: Global ICON[HH.Stand]: Global ICON[H.Stemless]	14	0	14	<4	0	<4
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Nano[H.Stemless]	607	<4	606	53	0	53
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	173	0	173	36	0	36
	Zimmer Biomet	TM[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	100	<4	99	0	0	0
	Zimmer Biomet	Anatomical[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	72	0	72	7	0	7
	Zimmer Biomet	TM[G.Ana]: Bigliani/Flatow[HH.Stand]: Sidus[H.Stemless]	33	0	33	0	0	0
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: Sidus[H.Stemless]	18	0	18	0	0	0
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	27	0	27	0	0	0
	Wright	Affiniti[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	10	0	10	0	0	0
	Wright	Aequalis Perform+[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	820	<4	819	159	0	159
	Wright	Aequalis[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	85	0	85	0	0	0
	Mathys	Affinis[G.Ana:HH.Stand:H.Stemless]	2,221	0	2,221	207	0	207
	Lima	SMR[G.Ana:HH.Stand:H.Stemless]	57	0	57	10	0	10
	Lima	SMR[G.BP:G.Lin:HH.Stand:H.Stemless]	171	0	171	21	0	21
	Zimmer Biomet	TESS[G.Ana:HH.Stand:H.Stemless]	69	0	69	0	0	0

Table 3.S5 (f) Number of stemmed conventional total shoulder replacements between 2012 and 2021 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed TSR	Wright	Aequalis Perform+[G.Ana]: Aequalis[HH.Stand]: Aequalis[H.Standard]	50	0	50	0	0	0
	Wright	Aequalis[G.Ana]: Aequalis[HH.Stand]: Aequalis-Press-Fit[H.Standard]	10	0	10	0	0	0
	Wright	Aequalis Perform+[G.Ana]: Affiniti[HH.Stand]: Affiniti[H.Standard]	12	0	12	0	0	0
	Zimmer Biomet	TM[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	116	0	116	0	0	0
	Zimmer Biomet	TM[G.Ana]: Anatomical[HH.Stand]: Anatomical[H.Mod]	12	<4	11	0	0	0
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	69	0	69	0	0	0
	Zimmer Biomet	Anatomical[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	24	0	24	0	0	0
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Anatomical[HH.Stand]: Anatomical[H.Mod]	11	0	11	<4	0	<4
	Zimmer Biomet	TM Reverse[G.BP]: TM[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	18	0	18	0	0	0
	Wright	Aequalis[G.Ana]: Ascend[HH.Stand]: Ascend[H.Standard]	24	0	24	0	0	0
	Wright	Aequalis Perform+[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	1,584	0	1,584	243	0	243
	Wright	Aequalis[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	20	0	20	0	0	0
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	977	<4	974	81	<4	80
	Zimmer Biomet	Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	15	0	15	<4	0	<4
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global AP[H.Mod]	172	0	172	31	0	31
	DePuy	Global[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	59	0	59	0	0	0
	DePuy	Global Anchor Peg[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	1,057	0	1,057	5	0	5
	DePuy	Global[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	559	0	559	22	0	22
	DePuy	Global Anchor Peg[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	274	0	274	31	0	31
	DePuy	Global[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	38	0	38	0	0	0
	Arthrex:DePuy	Univers II[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	22	0	22	<4	0	<4
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.Mod]	27	0	27	<4	0	<4
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	533	<4	532	34	0	34
	Lima	Axioma[G.Peg]: Axioma[G.BP]: SMR[G.Lin]: SMR[HH.Stand]: SMR[H.NeckBody]: SMR[H.Dia]	34	0	34	<4	0	<4

Table 3.S5 (f) (continued)

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed TSR	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: TM[H.Dia]	30	0	30	0	0	0
	Zimmer Biomet	TM[G.Ana]: Bigliani/Flatow[HH.Stand]: TM[H.Dia]	47	0	47	0	0	0
	Wright	Aequalis[G.Ana:HH.Stand:H.Standard]	195	0	195	0	0	0
	Mathys	Affinis[G.Ana:HH.Stand:H.Standard]	106	<4	105	4	0	4
	Zimmer Biomet	Anatomical[G.Ana:HH.Stand:H.Mod]	85	0	85	0	0	0
	FH	Arrow[G.BP:G.Lin:HH.Stand:H.Standard]	23	0	23	7	0	7
	FH	Arrow[G.Ana:HH.Stand:H.Standard]	181	0	181	16	0	16
	Zimmer Biomet	Bigliani/Flatow[G.Ana:HH.Stand:H.Dia]	58	0	58	0	0	0
	DePuy	Epoca[G.Ana:HH.Stand:H.Mod]	315	0	315	0	0	0
	DePuy	Epoca[G.BP:G.Ana:HH.Stand:H.Mod]	62	<4	60	0	0	0
	DePuy	Epoca[G.Peg:G.Ana:HH.Stand:H.Mod]	155	0	155	0	0	0
	Exactech	Equinoxe[G.Ana:HH.Stand:H.Mod]	1,291	<4	1,289	124	0	124
	Medacta	Medacta[G.Ana:HH.Stand:H.NeckBody:H.Standard]	23	0	23	4	0	4
	Lima	SMR[G.BP:G.Lin:HH.Stand:H.NeckBody:H.Dia]	415	0	415	7	0	7
	Lima	SMR[G.Ana:HH.Stand:H.NeckBody:H.Dia]	52	0	52	<4	0	<4
	JRI	Vaios[G.BP:G.Ana:HH.Stand:H.NeckBody:H.Dia]	126	0	126	<4	0	<4

Table 3.S5 (g) Number of stemless reverse polarity total shoulder replacements between 2012 and 2021 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemless RTSR	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Nano[H.Stemless]	37	0	37	0	0	0
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.Stemless]	182	0	182	46	0	46
	Zimmer Biomet	TESS[G.BP:G.Sph:H.RevBear:H.Stemless]	11	0	11	0	0	0

Table 3.S5 (h) Number of stemmed reverse polarity total shoulder replacement replacements between 2012 and 2021 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed RTSR	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis Reversed Fracture[H.Spacer]: Aequalis Reversed Fracture[H.Standard]	11	9	<4	<4	<4	0
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Aequalis Reversed Fracture[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	77	55	22	18	15	<4
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	120	93	27	31	26	5
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Aequalis Reversed Fracture[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	52	36	16	14	10	4
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	424	326	98	44	34	10
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis-Reversed II[H.RevCup]: Aequalis-Reversed II[H.Dia]	169	10	159	43	<4	42
	DJO	RSP[G.BP]: RSP[G.Sph]: RSP[H.RevBear]: AltiVate[H.Standard]	9	0	9	7	0	7
	Zimmer Biomet	TM Reverse[G.BP]: TM Reverse[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical[H.Mod]	1,186	38	1,148	104	<4	103
	Zimmer Biomet	Anatomical I/R[G.BP]: Anatomical I/R[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical[H.Mod]	13	0	13	0	0	0
	Zimmer Biomet	TM Reverse[G.BP]: TM Reverse[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical Fracture[H.Mod]	157	130	27	23	21	<4
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.Standard]	15	<4	14	6	0	6
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.Standard]	15	<4	14	<4	0	<4
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,679	19	1,660	217	<4	215
	Wright	Aequalis Perform Reversed[G.BP]: Unbranded[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	30	0	30	9	0	9
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,524	45	1,479	447	10	437
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial Glenosphere[G.Sph]: Comprehensive[H.RevBear]: Comprehensive[H.Standard]	13	<4	12	<4	0	<4

Table 3.S5 (h) (continued)

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed RTSR	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive[H.Standard]	2,736	121	2,615	317	26	291
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive Fracture[H.Standard]	564	456	108	88	77	11
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive Segmental Revision[H.NeckBody]: Comprehensive Segmental Revision[H.Dia]	20	5	15	<4	0	<4
	DePuy	Delta Xtend[G.BP]: Delta Xtend[G.Sph]: Delta Xtend[H.RevBear]: Delta Xtend[H.RevCup]: Global Unite[H.Mod]	128	77	51	27	15	12
	Lima	Axioma[G.BP]: SMR[G.Sph]: SMR[H.RevBear]: SMR[H.RevCup]: SMR[H.Dia]	95	4	91	<4	<4	0
	Lima	Axioma[G.Peg]: Axioma[G.BP]: SMR[G.Sph]: SMR[H.RevBear]: SMR[H.RevCup]: SMR[H.Dia]	106	<4	104	5	0	5
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: TM Reverse[H.RevBear]: TM Reverse[H.Mod]	47	0	47	8	0	8
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.Spacer]: Univers Reverse[H.Standard]	13	<4	12	<4	0	<4
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.RevCup]: Univers Reverse[H.Spacer]: Univers Reverse[H.Standard]	10	<4	8	0	0	0
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.Standard]	209	22	187	17	<4	15
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.RevCup]: Univers Reverse[H.Standard]	52	7	45	<4	0	<4
	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.Dia]	19	0	19	0	0	0
	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,232	27	1,205	53	0	53
	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Dia]	18	0	18	<4	0	<4
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Spacer:H.Standard]	15	<4	13	0	0	0
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Standard]	878	34	844	53	<4	51
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Dia]	233	177	56	40	31	9
	FH	Arrow[G.BP:G.Sph:H.RevBear:H.Standard]	199	37	162	28	12	16
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Standard]	3,222	605	2,617	229	60	169
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Spacer:H.Standard]	89	34	55	4	<4	<4
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Mod]	2,858	80	2,778	229	16	213
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Mod]	23	<4	20	<4	0	<4
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Mod]	43	4	39	0	0	0

Table 3.S5 (h) (continued)

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2021		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed RTSR	Exactech	Equinoxe[G.BP:G.Sph:H.RevBear:H.Standard]	518	412	106	96	76	20
	Exactech	Equinoxe[G.BP:G.Sph:H.RevBear:H.Mod]	3,291	61	3,230	486	11	475
	Stanmore	METS[G.Sph:H.RevBear:H.Mod]	12	0	12	0	0	0
	DJO	RSP[G.BP:G.Sph:H.RevBear:H.Standard]	553	47	506	92	9	83
	DJO	RSP[G.BP:G.Sph:H.RevBear:H.Mod]	28	<4	25	0	0	0
	DJO	RSP[G.BP:G.Sph:H.RevBear:H.Spacer:H.Standard]	13	<4	11	4	<4	<4
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Dia]	165	40	125	11	4	7
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	2,005	375	1,630	202	44	158
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.Dia]	10	4	6	<4	0	<4
	Zimmer Biomet	TM Reverse[G.BP:G.Sph:H.RevBear:H.Mod]	736	83	653	65	10	55
	Zimmer Biomet	TM Reverse[G.BP:G.Sph:H.RevBear:H.Spacer:H.Mod]	10	<4	7	0	0	0
	JRI	Vaios[G.BP:G.Sph:H.RevBear:H.NeckBody:H.Dia]	384	38	346	19	7	12
	Innovative	Verso[G.BP:G.Sph:H.RevBear:H.Standard]	700	44	656	79	4	75

The notes below apply to the tables on the previous pages.

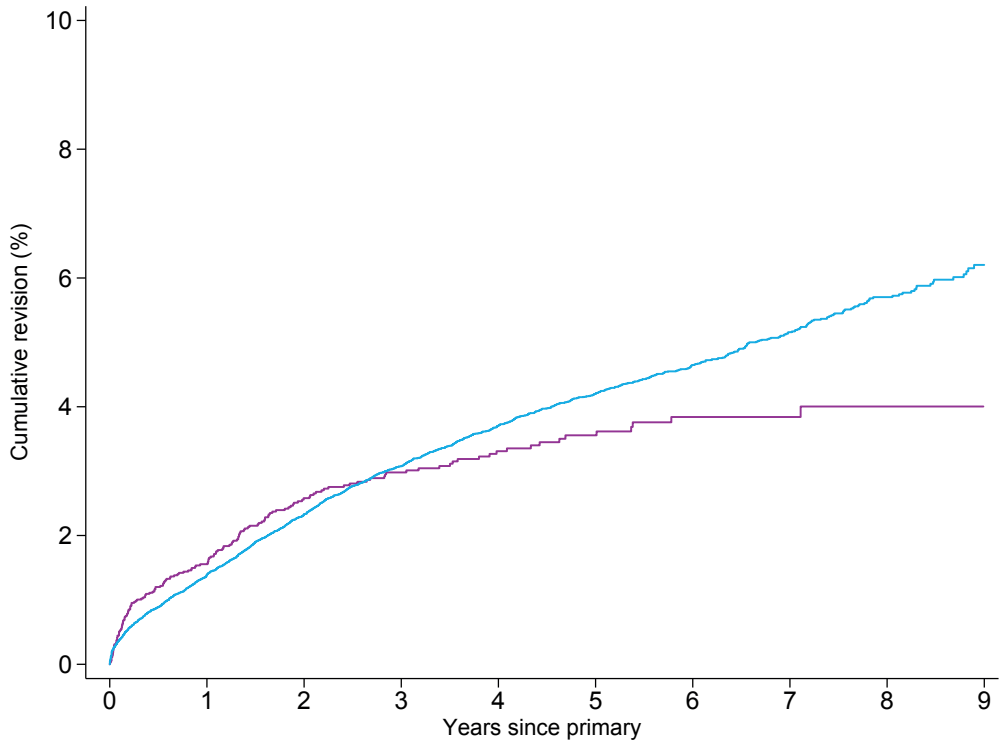
Note: HH.=Humeral head, H.=Humerus, G.=Glenoid, Resurf=Resurfacing, RPeg=Resurfacing peg, Ana=Anatomic, BP=Baseplate, Peg=Peg, Stand=Standard, Lin=Liner, Sph=Sphere, RevBear=Reverse bearing, Stand=Standard, NeckBody=Modular neck body, Mod=Modular Stem, MBStem=Monobloc stem, Dia=Diaphyseal stem, RevBear=Reverse bearing, RevCup=Reverse cup.
Note: Data are sorted by the brand of the humeral component.

Table 3.S5 (a) to Table 3.S5 (h) on page 267 to 275 illustrate the shoulder construct used by sub-type of the primary shoulder replacement for overall procedures and by acute and elective sub-divisions. They also show this data for the last year. Implants are only listed if they have been used on more than ten occasions overall or five occasions within the last year. Results illustrate the frequency of all implanted constructs across all years of data collection within the registry i.e., between 2012 and 2021. The frequency of shoulder constructs within the last year of the data collection is also illustrated to indicate contemporary practice. Constructs and prostheses elements are suffixed '[ ]' to indicate the implants that make up the construct. In the cases of 'within manufacturer and brand' construct, this suffix is placed after the brand name, whereas within 'mix and match' constructs, the suffix is placed immediately after the brand of the implanted element. While the detail in reporting of constructs has become more granular, the complexity has necessarily increased to reflect the diversity of implanted elements and will facilitate improved implant scrutiny. Given the rapid evolution and heterogeneity of shoulder prostheses, it is expected that the classification system will evolve with the introduction of new types of prostheses and the combinations in which these are used by surgeons.

3.6.2 Revisions after primary shoulder replacement surgery

We present results in this section as percentage cumulative revision of primary shoulder replacements. Results are estimated using the 1-Kaplan-Meier method; 95% CIs are shown within tables and when number at risk falls below 250, estimates are shown in blue italics to indicate that caution is required in interpreting the results. Data are presented up to nine years which is the last full year of data collection within the registry. Figures also include an 'at-risk table' which presents the number of individuals at risk of revision at the time indicated.

Figure 3.S5 KM estimates of cumulative revision for primary shoulder replacement by acute trauma and elective cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
Acute trauma	6,108	4,973	4,078	3,113	2,297	1,590	1,050	626	323	*79*
Elective	50,204	44,290	39,794	32,146	25,139	18,745	13,081	8,388	4,439	1,523

Figure 3.S5 and Table 3.S6 (page 277) illustrate the cumulative revision of primary shoulder procedures performed overall (shown in Table 3.S6 only) and by acute trauma and elective procedures. Our results indicate that the risk of revision is comparable for the first three years following surgery, at which point it starts to diverge. Beyond three years, the risk of revision for acute trauma patients tends to be lower, but the number of patients still at risk at nine years is small and therefore should be interpreted cautiously.

Table 3.S6 KM estimates of cumulative revision (95% CI) for primary shoulder replacement for all cases, acute trauma and elective cases.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

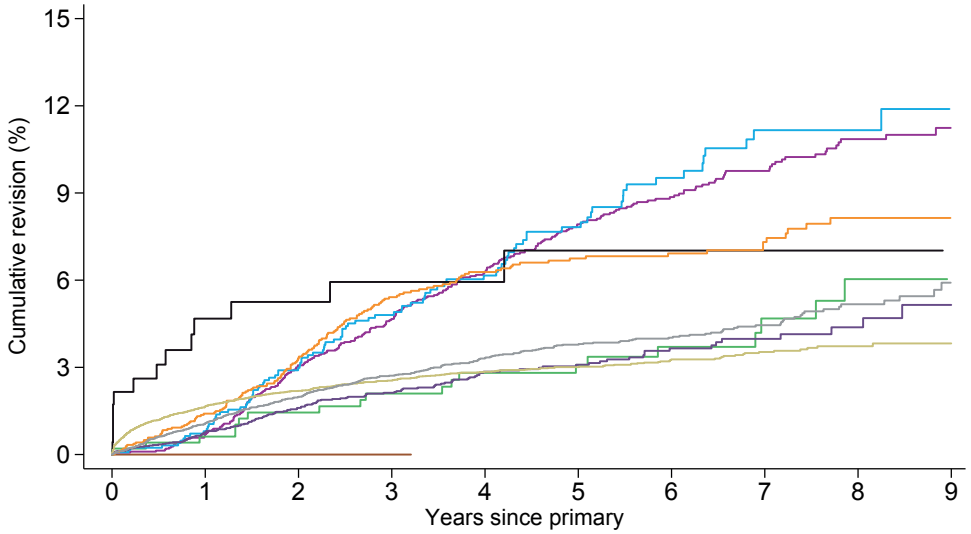
	N	Age at primary Median (IQR)	Male (%)	Time since primary								
				1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
All cases	56,312	73 (67 to 79)	30	1.41 (1.31-1.51)	2.36 (2.23-2.49)	3.07 (2.92-3.23)	3.68 (3.51-3.86)	4.15 (3.96-4.35)	4.59 (4.38-4.81)	5.06 (4.82-5.31)	5.58 (5.29-5.88)	6.05 (5.67-6.44)
Acute trauma	6,108	73 (67 to 79)	23	1.55 (1.27-1.91)	2.58 (2.19-3.05)	2.98 (2.54-3.49)	3.31 (2.83-3.87)	3.56 (3.04-4.16)	3.84 (3.26-4.52)	3.84 (3.26-4.52)	4.00 (3.36-4.77)	*4.00 (3.36-4.77)*
Elective	50,204	73 (67 to 79)	31	1.39 (1.29-1.50)	2.33 (2.20-2.47)	3.08 (2.92-3.24)	3.71 (3.53-3.90)	4.20 (4.00-4.41)	4.65 (4.43-4.88)	5.16 (4.90-5.43)	5.70 (5.40-6.03)	6.20 (5.81-6.63)

Table 3.S7 KM estimates of cumulative revision (95% CI) for primary shoulder replacement for elective cases by gender and age group. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Gender	Age at primary (years)	N	Time since primary								
			1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
Female	All	34,766	0.99 (0.89-1.11)	1.84 (1.70-2.00)	2.50 (2.33-2.68)	3.03 (2.83-3.23)	3.49 (3.27-3.72)	3.88 (3.63-4.14)	4.36 (4.07-4.66)	4.93 (4.58-5.31)	5.40 (4.95-5.89)
	<55	1,245	2.60 (1.83-3.67)	4.93 (3.83-6.35)	7.31 (5.92-9.01)	8.50 (6.96-10.36)	9.82 (8.11-11.87)	10.21 (8.43-12.34)	11.39 (9.35-13.85)	*12.17 (9.92-14.88)*	*12.77 (10.31-15.77)*
	55 to 64	3,685	1.29 (0.96-1.72)	2.69 (2.19-3.31)	3.82 (3.20-4.56)	4.82 (4.09-5.67)	5.93 (5.08-6.92)	6.89 (5.92-8.02)	7.96 (6.83-9.26)	9.07 (7.72-10.64)	*11.00 (9.06-13.32)*
	65 to 74	12,768	1.06 (0.89-1.26)	1.98 (1.74-2.24)	2.73 (2.44-3.05)	3.32 (2.99-3.68)	3.79 (3.43-4.20)	4.20 (3.80-4.64)	4.81 (4.33-5.33)	5.59 (4.99-6.25)	5.93 (5.22-6.74)
	≥75	17,068	0.76 (0.64-0.91)	1.32 (1.16-1.52)	1.66 (1.46-1.88)	1.97 (1.75-2.22)	2.19 (1.95-2.46)	2.43 (2.15-2.73)	2.54 (2.25-2.87)	2.71 (2.38-3.09)	2.71 (2.38-3.09)
Male	All	15,438	2.29 (2.06-2.54)	3.44 (3.15-3.76)	4.40 (4.06-4.76)	5.27 (4.89-5.68)	5.83 (5.42-6.28)	6.42 (5.96-6.92)	7.01 (6.48-7.57)	7.48 (6.88-8.13)	8.05 (7.28-8.90)
	<55	1,637	2.79 (2.09-3.74)	5.31 (4.28-6.57)	7.33 (6.09-8.81)	9.62 (8.14-11.35)	10.92 (9.29-12.81)	12.66 (10.80-14.82)	14.30 (12.16-16.79)	*14.59 (12.40-17.14)*	*15.92 (13.19-19.14)*
	55 to 64	2,973	2.03 (1.57-2.63)	3.33 (2.71-4.09)	4.44 (3.70-5.32)	5.23 (4.40-6.21)	5.80 (4.90-6.86)	6.58 (5.56-7.79)	7.04 (5.92-8.37)	7.31 (6.09-8.75)	*8.54 (6.62-10.99)*
	65 to 74	5,837	2.07 (1.73-2.48)	3.01 (2.59-3.51)	3.70 (3.22-4.25)	4.50 (3.95-5.13)	5.17 (4.55-5.88)	5.59 (4.91-6.35)	6.10 (5.34-6.96)	6.89 (5.94-8.00)	*6.89 (5.94-8.00)*
	≥75	4,991	2.51 (2.11-3.00)	3.37 (2.88-3.94)	4.19 (3.63-4.84)	4.62 (4.01-5.32)	4.72 (4.10-5.44)	4.87 (4.22-5.61)	5.10 (4.39-5.93)	5.28 (4.50-6.18)	*5.70 (4.64-7.01)*

Table 3.S7 (page 278) further breaks down the cumulative revision of primary shoulder procedures for elective patients, by gender and age group. Results indicate that females have a lower risk of revision compared to males and that younger patients have an increased risk of revision compared to older patients. This is especially true for patients under 55 years who after three years have substantially higher revision rates at each subsequent time point.

Figure 3.S6 KM estimates of cumulative revision for primary elective shoulder replacement by type of shoulder replacement. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
Resurfacing HHA	2,983	2,881	2,708	2,471	2,219	1,922	1,541	1,165	730	309
Stemless HHA	1,291	1,208	1,121	924	728	551	390	266	*146*	*41*
Stemmed HHA	2,422	2,239	2,062	1,766	1,500	1,238	955	656	387	*152*
Resurfacing TSR	487	480	464	436	400	351	273	*191*	*117*	*36*
Stemless TSR	5,602	4,896	4,312	3,334	2,444	1,720	1,123	659	308	*105*
Stemmed TSR	8,999	8,229	7,612	6,489	5,358	4,124	2,970	1,890	971	327
Stemless RTSR	*232*	*173*	*152*	*126*	*90*	*67*	*43*	*22*	*10*	*<4*
Stemmed RTSR	23,264	19,952	17,542	13,328	9,770	6,682	4,258	2,491	1,177	340
IPA	*5*	*5*	*5*	*<4*						

Note: HHA=Humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S8 KM estimates of cumulative revision (95% CI) for primary shoulder replacement for elective cases by shoulder type. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Elective	N	Age at primary median (IQR)	Male (%)	Time since primary								
				1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
Proximal humeral hemiarthroplasty	**6,696**	**70 (61 to 77)**	**34**	**0.97 (0.76-1.24)**	**3.15 (2.75-3.61)**	**4.96 (4.44-5.54)**	**6.27 (5.68-6.92)**	**7.53 (6.86-8.26)**	**8.33 (7.61-9.11)**	**9.16 (8.38-10.01)**	**10.03 (9.16-10.98)**	**10.35 (9.41-11.37)**
Resurfacing	2,983	71 (63 to 78)	31	0.68 (0.44-1.06)	3.07 (2.50-3.77)	4.67 (3.95-5.51)	6.27 (5.42-7.25)	7.92 (6.94-9.03)	8.86 (7.81-10.05)	9.76 (8.63-11.03)	10.85 (9.59-12.27)	11.24 (9.88-12.77)
Stemless	1,291	67 (56 to 75)	43	0.80 (0.43-1.49)	2.99 (2.16-4.12)	4.80 (3.71-6.20)	6.16 (4.88-7.77)	7.83 (6.30-9.70)	9.52 (7.71-11.72)	11.16 (9.03-13.76)	*11.16 (9.03-13.76)*	*11.89 (9.43-14.93)*
Stemmed	2,422	70 (60 to 78)	32	1.41 (1.00-1.97)	3.32 (2.66-4.15)	5.42 (4.54-6.46)	6.28 (5.32-7.41)	6.75 (5.73-7.93)	6.92 (5.88-8.13)	7.31 (6.20-8.61)	8.14 (6.85-9.66)	*8.14 (6.85-9.66)*
Total shoulder replacement	**15,088**	**70 (63 to 75)**	**32**	**0.95 (0.80-1.12)**	**1.83 (1.62-2.07)**	**2.48 (2.23-2.76)**	**3.13 (2.84-3.46)**	**3.52 (3.20-3.88)**	**3.87 (3.51-4.26)**	**4.31 (3.90-4.76)**	**5.01 (4.48-5.60)**	**5.69 (4.95-6.54)**
Resurfacing	487	71 (63 to 76)	29	0.62 (0.20-1.90)	1.45 (0.69-3.01)	2.10 (1.13-3.87)	2.81 (1.64-4.80)	3.09 (1.83-5.17)	3.71 (2.27-6.02)	*4.68 (2.90-7.53)*	*6.04 (3.72-9.71)*	*6.04 (3.72-9.71)*
Stemless	5,602	69 (62 to 75)	36	0.77 (0.56-1.04)	1.60 (1.29-2.00)	2.12 (1.75-2.58)	2.85 (2.38-3.42)	3.09 (2.58-3.70)	3.65 (3.03-4.40)	3.98 (3.28-4.83)	4.38 (3.52-5.44)	*5.15 (3.89-6.79)*
Stemmed	8,999	71 (65 to 76)	29	1.07 (0.88-1.31)	1.99 (1.71-2.31)	2.71 (2.38-3.09)	3.32 (2.94-3.75)	3.78 (3.36-4.25)	4.02 (3.58-4.52)	4.45 (3.95-5.01)	5.17 (4.53-5.90)	5.91 (4.98-7.01)
Reverse polarity total shoulder replacement	**23,496**	**76 (71 to 80)**	**29**	**1.68 (1.52-1.86)**	**2.22 (2.03-2.43)**	**2.58 (2.37-2.80)**	**2.88 (2.65-3.12)**	**3.05 (2.81-3.31)**	**3.31 (3.04-3.61)**	**3.56 (3.24-3.91)**	**3.76 (3.39-4.16)**	**3.85 (3.45-4.31)**
Stemless	232	74 (70 to 78)	36	*4.68 (2.54-8.54)*	*5.25 (2.93-9.32)*	*5.94 (3.39-10.30)*	*5.94 (3.39-10.30)*	*7.02 (4.01-12.13)*	*7.02 (4.01-12.13)*	*7.02 (4.01-12.13)*	*7.02 (4.01-12.13)*	
Stemmed	23,264	76 (71 to 80)	29	1.65 (1.49-1.83)	2.19 (2.00-2.40)	2.54 (2.34-2.77)	2.85 (2.62-3.10)	3.01 (2.77-3.27)	3.27 (3.00-3.57)	3.53 (3.21-3.88)	3.73 (3.36-4.14)	3.82 (3.42-4.28)
Interpositional arthroplasty	**5**	**58 (55 to 68)**	**60**									
Unconfirmed	**4,919**	**73 (66 to 78)**	**32**	**1.94 (1.58-2.38)**	**3.07 (2.60-3.62)**	**4.12 (3.56-4.77)**	**4.84 (4.22-5.55)**	**5.40 (4.72-6.18)**	**6.06 (5.31-6.92)**	**6.76 (5.91-7.74)**	**6.97 (6.08-7.99)**	*8.16 (6.86-9.71)*
Unconfirmed HHA	317	69 (58 to 75)	36	1.27 (0.48-3.35)	3.79 (2.12-6.75)	*6.15 (3.86-9.73)*	*7.15 (4.60-11.04)*	*7.15 (4.60-11.04)*	*7.80 (5.05-11.95)*	*9.60 (6.23-14.66)*	*9.60 (6.23-14.66)*	*9.60 (6.23-14.66)*
Unconfirmed TSR	1,922	69 (61 to 76)	36	1.12 (0.73-1.72)	2.72 (2.06-3.58)	4.14 (3.30-5.18)	5.12 (4.17-6.27)	6.11 (5.05-7.39)	6.79 (5.64-8.17)	7.56 (6.28-9.08)	7.75 (6.43-9.33)	*9.41 (7.46-11.82)*
Unconfirmed RTSR	2,675	75 (69 to 80)	29	2.64 (2.08-3.35)	3.17 (2.54-3.95)	3.71 (3.00-4.57)	4.10 (3.33-5.04)	4.20 (3.41-5.17)	4.84 (3.91-5.98)	5.18 (4.16-6.45)	*5.46 (4.34-6.86)*	*6.02 (4.56-7.92)*
Unconfirmed IPA	5	64 (60 to 65)	60									

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S8 (page 280) and Figure 3.S6 (page 279) report cumulative revision of primary shoulder procedures, for elective patients, by type (Table 3.S8 only) and sub-type of shoulder construct.

Proximal humeral hemiarthroplasties undergo revision at a higher rate than either conventional total shoulder replacements or reverse polarity total shoulder replacements. The extent to which proximal humeral hemiarthroplasty procedures are seen as 'revisable' procedures compared to total shoulder replacements should be considered when interpreting the results. Furthermore, while Table 3.S8 and Figure 3.S6 suggest a stemmed proximal humeral hemiarthroplasty might be the better choice over a stemless or resurfacing humeral hemiarthroplasty, the latter group are more straightforward to revise than for a stemmed implant and so caution is again needed interpreting these sub-group results.

The cumulative risk of revision of stemless reverse polarity total shoulder replacements is higher compared to stemmed versions. This also needs careful interpretation as the number of stemless reverse polarity replacements is low, however, it is worth noting that some stemless reverse polarity brands have been withdrawn from the market. The performance of stemmed conventional total shoulder replacement compared to stemmed reverse polarity shoulder replacements is of particular interest. Reverse polarity total shoulder replacements tend to have an initially higher revision rate which then plateaus, whereas the conventional total shoulder replacements increase more slowly but at a constant rate and therefore exceed the cumulative risk of revision of reverse polarity total replacements and overall is 1.8% higher at nine years. The extent to which the different indications for surgery are confounding results is not clear and so results should be interpreted cautiously.

Table 3.S9 KM estimates of cumulative revision (95% CI) for primary shoulder replacement for elective cases by brand construct in constructs with greater than 250 implantations. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

	Shoulder construct	N	Time since primary								
			1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
Resurfacing HHA	Aequalis Resurfacing[HH.Resurf]	254	0.40 (0.06-2.77)	*2.78 (1.34-5.75)*	*4.40 (2.46-7.80)*	*5.25 (3.08-8.87)*	*6.65 (4.12-10.64)*	*7.67 (4.89-11.93)*	*8.96 (5.83-13.65)*	*8.96 (5.83-13.65)*	*8.96 (5.83-13.65)*
	Copeland[HH.Resurf]	1,666	0.43 (0.20-0.89)	2.32 (1.68-3.18)	3.71 (2.88-4.77)	5.12 (4.12-6.36)	6.94 (5.74-8.39)	7.67 (6.39-9.20)	8.86 (7.44-10.55)	9.98 (8.40-11.84)	*10.37 (8.65-12.40)*
	Global CAP[HH.Resurf]	622	0.98 (0.44-2.17)	3.35 (2.17-5.15)	4.79 (3.33-6.86)	6.95 (5.12-9.40)	8.46 (6.39-11.15)	9.99 (7.67-12.95)	*10.29 (7.92-13.31)*	*11.42 (8.71-14.90)*	*12.31 (9.24-16.31)*
Stemless HHA	Affinis[HH.Stand:H.Stemless]	621	0.33 (0.08-1.33)	2.79 (1.72-4.52)	2.98 (1.86-4.75)	4.51 (2.99-6.76)	*5.83 (3.97-8.51)*	*7.48 (5.08-10.93)*	*8.21 (5.55-12.04)*	*8.21 (5.55-12.04)*	*8.21 (5.55-12.04)*
Stemmed HHA	Aequalis[HH.Stand]: Ascend Flex[H.Standard]	282	*2.18 (0.98-4.78)*	*4.82 (2.76-8.37)*	*6.32 (3.84-10.33)*	*6.32 (3.84-10.33)*	*8.38 (5.08-13.69)*	*8.38 (5.08-13.69)*			
	Global Advantage[HH.Stand:H.Standard]	260	1.17 (0.38-3.59)	*1.57 (0.59-4.14)*	*4.10 (2.23-7.50)*	*4.56 (2.55-8.09)*	*5.03 (2.89-8.71)*	*5.55 (3.25-9.38)*	*5.55 (3.25-9.38)*	*5.55 (3.25-9.38)*	*5.55 (3.25-9.38)*
Stemless TSR	Univers II[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	484	0.21 (0.03-1.46)	1.20 (0.50-2.86)	2.02 (1.01-4.01)	*2.79 (1.49-5.19)*	*2.79 (1.49-5.19)*	*5.88 (3.03-11.26)*	*5.88 (3.03-11.26)*	*5.88 (3.03-11.26)*	*5.88 (3.03-11.26)*
	Global Anchor Peg[G.Ana]: Global ICON[HH.Stand]: Global ICON[H.Stemless]	310	*0.33 (0.05-2.32)*	*0.83 (0.20-3.37)*	*0.83 (0.20-3.37)*						
	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Nano[H.Stemless]	606	1.20 (0.58-2.51)	2.56 (1.52-4.28)	3.46 (2.19-5.45)	4.07 (2.62-6.29)	*5.34 (3.48-8.15)*	*5.34 (3.48-8.15)*	*5.34 (3.48-8.15)*	*5.34 (3.48-8.15)*	
	Aequalis Perform+[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	819	0.73 (0.30-1.75)	1.69 (0.94-3.04)	1.89 (1.07-3.31)	1.89 (1.07-3.31)	*1.89 (1.07-3.31)*	*1.89 (1.07-3.31)*	*1.89 (1.07-3.31)*		
	Affinis[G.Ana:HH.Stand:H.Stemless]	2,221	0.38 (0.19-0.76)	0.80 (0.49-1.30)	1.16 (0.76-1.76)	1.32 (0.88-1.98)	1.43 (0.96-2.13)	1.61 (1.06-2.43)	2.12 (1.34-3.36)	*2.12 (1.34-3.36)*	*2.12 (1.34-3.36)*
Stemmed TSR	Aequalis Perform+[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	1,584	0.21 (0.07-0.66)	0.61 (0.30-1.21)	1.08 (0.63-1.87)	2.11 (1.34-3.32)	2.11 (1.34-3.32)	*2.11 (1.34-3.32)*	*2.98 (1.55-5.69)*		
	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	974	1.60 (0.97-2.65)	3.00 (2.07-4.35)	4.23 (3.07-5.83)	4.77 (3.49-6.50)	5.04 (3.69-6.88)	*5.34 (3.90-7.30)*	*5.34 (3.90-7.30)*	*5.34 (3.90-7.30)*	*5.34 (3.90-7.30)*
	Global Anchor Peg[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	1,057	0.29 (0.09-0.88)	0.86 (0.45-1.65)	1.16 (0.66-2.04)	1.48 (0.89-2.44)	1.71 (1.07-2.75)	2.14 (1.38-3.32)	2.14 (1.38-3.32)	2.40 (1.54-3.75)	*2.40 (1.54-3.75)*
	Global Anchor Peg[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	274	*0.40 (0.06-2.83)*	*1.71 (0.65-4.50)*	*2.19 (0.91-5.18)*	*2.19 (0.91-5.18)*	*2.77 (1.24-6.10)*	*2.77 (1.24-6.10)*	*2.77 (1.24-6.10)*	*2.77 (1.24-6.10)*	
	Global[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	559	0.55 (0.18-1.70)	0.93 (0.39-2.22)	1.34 (0.64-2.78)	1.79 (0.93-3.42)	2.33 (1.29-4.20)	2.33 (1.29-4.20)	*2.33 (1.29-4.20)*	*3.29 (1.62-6.61)*	*3.29 (1.62-6.61)*
	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	532	0.78 (0.29-2.05)	1.60 (0.80-3.17)	1.85 (0.96-3.53)	1.85 (0.96-3.53)	*2.18 (1.16-4.06)*	*2.18 (1.16-4.06)*	*2.18 (1.16-4.06)*		
	Epoca[G.Ana:HH.Stand:H.Mod]	315	0.32 (0.04-2.23)	0.65 (0.16-2.56)	1.30 (0.49-3.44)	1.98 (0.90-4.36)	*1.98 (0.90-4.36)*	*1.98 (0.90-4.36)*	*2.53 (1.19-5.33)*	*3.37 (1.60-7.00)*	*3.37 (1.60-7.00)*
	Equinoxe[G.Ana:HH.Stand:H.Mod]	1,289	1.23 (0.74-2.03)	2.14 (1.45-3.15)	3.16 (2.27-4.38)	3.86 (2.83-5.26)	4.19 (3.08-5.68)	4.19 (3.08-5.68)	*5.25 (3.76-7.30)*	*6.04 (4.11-8.85)*	*6.04 (4.11-8.85)*
	SMR[G.BP:G.Lin:HH.Stand:H.NeckBody:H.Dia]	415	3.16 (1.85-5.39)	5.66 (3.80-8.40)	7.80 (5.55-10.92)	9.01 (6.54-12.34)	*10.05 (7.39-13.59)*	*10.05 (7.39-13.59)*	*10.62 (7.81-14.36)*	*13.66 (9.71-19.03)*	*13.66 (9.71-19.03)*

Note: HH.=Humeral head, H.=Humerus, G.=Glenoid, Resurf=Resurfacing, RPeg=Resurfacing peg, Ana=Anatomic, BP=Baseplate, Peg=Peg, Stand=Standard, Lin=Liner, Sph=Sphere, RevBear=Reverse bearing, Stand=Standard, NeckBody=Modular neck body, Mod=Modular Stem, MBStem=Monobloc stem, Dia=Diaphyseal stem, RevBear=Reverse bearing, RevCup=Reverse cup.
Note: Data are sorted by the brand of the humeral component.

Table 3.S9 (continued)

	Shoulder construct	N	Time since primary								
			1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
Stemmed RTSR	TM Reverse[G.BP]: TM Reverse[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical[H.Mod]	1,148	1.89 (1.24-2.89)	2.50 (1.72-3.62)	3.30 (2.36-4.59)	3.70 (2.68-5.09)	4.11 (2.98-5.64)	*4.48 (3.21-6.25)*	*4.48 (3.21-6.25)*	*4.48 (3.21-6.25)*	*4.48 (3.21-6.25)*
	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,660	1.19 (0.76-1.86)	1.71 (1.16-2.50)	1.79 (1.23-2.60)	1.79 (1.23-2.60)	1.79 (1.23-2.60)	*3.42 (2.03-5.71)*	*4.29 (2.42-7.54)*	*4.29 (2.42-7.54)*	
	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,479	1.55 (1.01-2.37)	1.97 (1.33-2.92)	2.79 (1.85-4.20)	*3.18 (2.06-4.88)*					
	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive[H.Standard]	2,615	1.27 (0.90-1.79)	1.50 (1.09-2.06)	1.73 (1.27-2.35)	1.79 (1.32-2.43)	1.89 (1.39-2.56)	1.89 (1.39-2.56)	*1.89 (1.39-2.56)*	*1.89 (1.39-2.56)*	*1.89 (1.39-2.56)*
	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,205	1.19 (0.71-2.01)	1.74 (1.12-2.68)	1.93 (1.28-2.93)	2.05 (1.37-3.08)	2.05 (1.37-3.08)	2.05 (1.37-3.08)	2.73 (1.72-4.30)	*4.06 (2.51-6.54)*	*4.06 (2.51-6.54)*
	Affinis[G.BP:G.Sph:H.RevBear:H.Standard]	844	3.28 (2.26-4.75)	4.22 (3.03-5.86)	4.86 (3.55-6.63)	5.33 (3.91-7.24)	5.90 (4.33-8.01)	*6.46 (4.65-8.93)*	*7.29 (5.06-10.45)*	*7.29 (5.06-10.45)*	*7.29 (5.06-10.45)*
	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Standard]	2,617	1.17 (0.82-1.67)	1.43 (1.03-1.98)	1.43 (1.03-1.98)	1.55 (1.13-2.13)	1.71 (1.25-2.34)	2.20 (1.58-3.05)	2.20 (1.58-3.05)	*2.20 (1.58-3.05)*	*2.20 (1.58-3.05)*
	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Mod]	2,778	1.19 (0.85-1.69)	1.68 (1.25-2.25)	1.87 (1.41-2.48)	1.87 (1.41-2.48)	2.02 (1.53-2.67)	2.24 (1.68-2.98)	2.61 (1.91-3.57)	*2.61 (1.91-3.57)*	*2.61 (1.91-3.57)*
	Equinoxe[G.BP:G.Sph:H.RevBear:H.Mod]	3,230	1.42 (1.06-1.91)	2.02 (1.56-2.61)	2.45 (1.93-3.12)	3.43 (2.73-4.29)	3.74 (2.98-4.69)	3.91 (3.10-4.93)	4.17 (3.25-5.35)	*4.17 (3.25-5.35)*	*4.17 (3.25-5.35)*
	RSP[G.BP:G.Sph:H.RevBear:H.Standard]	506	1.91 (1.00-3.66)	2.44 (1.35-4.37)	*2.75 (1.56-4.83)*	*3.16 (1.82-5.47)*	*3.80 (2.16-6.65)*	*3.80 (2.16-6.65)*	*3.80 (2.16-6.65)*		
	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,630	1.77 (1.22-2.55)	2.56 (1.88-3.49)	2.99 (2.23-4.01)	3.09 (2.31-4.13)	3.09 (2.31-4.13)	*3.09 (2.31-4.13)*	*3.09 (2.31-4.13)*	*3.09 (2.31-4.13)*	*3.09 (2.31-4.13)*
	TM Reverse[G.BP:G.Sph:H.RevBear:H.Mod]	653	0.97 (0.44-2.14)	1.33 (0.67-2.64)	1.74 (0.94-3.22)	2.56 (1.47-4.44)	*2.56 (1.47-4.44)*	*2.56 (1.47-4.44)*	*2.56 (1.47-4.44)*	*2.56 (1.47-4.44)*	
	Vaios[G.BP:G.Sph:H.RevBear:H.NeckBody:H.Dia]	346	2.66 (1.39-5.05)	3.92 (2.29-6.66)	4.61 (2.80-7.54)	*4.61 (2.80-7.54)*	*5.07 (3.12-8.17)*	*5.07 (3.12-8.17)*	*5.07 (3.12-8.17)*	*5.07 (3.12-8.17)*	*7.13 (3.68-13.56)*
	Verso[G.BP:G.Sph:H.RevBear:H.Standard]	656	2.37 (1.44-3.91)	3.10 (1.99-4.82)	3.10 (1.99-4.82)	3.46 (2.21-5.38)	*3.46 (2.21-5.38)*	*3.46 (2.21-5.38)*	*4.63 (2.55-8.35)*	*4.63 (2.55-8.35)*	*4.63 (2.55-8.35)*

Note: HH.=Humeral head, H.=Humerus, G.=Glenoid, Resurf=Resurfacing, RPeg=Resurfacing peg, Ana=Anatomic, BP=Baseplate, Peg=Peg, Stand=Standard, Lin=Liner, Sph=Sphere, RevBear=Reverse bearing, Stand=Standard, NeckBody=Modular neck body, Mod=Modular Stem, MBStem=Monobloc stem, Dia=Diaphyseal stem, RevBear=Reverse bearing, RevCup=Reverse cup.
Note: Data are sorted by the brand of the humeral component.

Table 3.S9 (page 282) reports cumulative revision of primary shoulder procedures for elective patients by shoulder construct. All constructs that have been used on more than 250 occasions are reported. Where the construct is solely built from within the same product line the elements used to build the construct are suffixed in [ ] following the brand. Where the construct is built from different product lines, the prosthesis is indicated in [ ] immediately after. The description of constructs is necessarily complex, this reflects the extensive modularity of modern shoulder prostheses. All results should be viewed in the context of observational data and due consideration given to the volume of unconfirmed prostheses.

Table 3.S10 PTIR estimates of indications for shoulder revision (95% CI) for acute trauma by type of shoulder replacement between 2012 and 2021.

Acute trauma	Events N	Prosthesis-years at risk (x100)	Number of revisions per 100 prosthesis-years at risk for: All causes	Infection	Instability | Dislocation	Cuff insufficiency	Aseptic loosening | Lysis	Peri-prosthetic fracture	Other indications
All cases	172	210.8	0.82 (0.70-0.95)	0.13 (0.09-0.19)	0.28 (0.22-0.36)	0.21 (0.16-0.29)	0.06 (0.03-0.10)	0.04 (0.02-0.08)	0.09 (0.05-0.14)
Proximal humeral hemiarthroplasty	91	78.1	1.17 (0.95-1.43)	0.14 (0.08-0.25)	0.23 (0.15-0.37)	0.53 (0.39-0.71)	0.05 (0.02-0.14)	0.01 (0.00-0.09)	0.18 (0.11-0.30)
Total shoulder replacement	0	0.8	0	0	0	0	0	0	0
Reverse polarity total shoulder replacement	65	113.2	0.57 (0.45-0.73)	0.13 (0.08-0.22)	0.29 (0.21-0.41)	0	0.05 (0.02-0.12)	0.04 (0.01-0.09)	0.03 (0.01-0.08)
Unconfirmed	16	18.8	0.85 (0.52-1.39)	0.05 (0.01-0.38)	0.42 (0.21-0.85)	0.21 (0.08-0.57)	0.11 (0.03-0.42)	0.16 (0.05-0.49)	0.05 (0.01-0.38)

Table 3.S10 and Table 3.S11 (page 285) describe the prosthesis time incidence rate (PTIR) per 100 years of follow-up for the reported indication for revision in acute trauma patients receiving a primary shoulder replacement. Table 3.S10 reports indications for all patients across the life of the registry i.e. between 2012 and 2021, this was achieved by aggregating indications for revision across the different minimum datasets. Table 3.S11 reports data for patients whose information was entered following the introduction of MDSv7.

Cuff insufficiency is the leading indication for revision for those who receive a proximal humeral hemiarthroplasty, whereas instability or dislocation, or infection are the leading causes in reverse polarity total shoulder replacements, see Table 3.S10. The low number of primary replacements and even lower frequency of revisions for patients whose data were entered using the most recent minimum dataset makes results difficult to interpret. It is important to note that the indications for revision are not mutually exclusive and 16.3%, 71.5%, and 9.9% recorded none, one and two indications for revision respectively.

Table 3.S11 PTIR estimates of indications for shoulder revision (95% CI) for acute trauma by type of shoulder replacement using reports from MDSv7.

Acute trauma	Events N	Prosthesis-years at risk (x100)	Number of revisions per 100 prosthesis-years at risk for:									
			All causes	Aseptic loosening humerus	Aseptic loosening glenoid	Stiffness	Component dissociation	Native glenoid surface erosion	Implant fracture	Lysis glenoid	Dislocation	Unexplained pain
All cases	62	50.4	1.23 (0.96-1.58)	0.04 (0.01-0.16)	0.02 (0.00-0.14)	0.06 (0.02-0.18)	0.06 (0.02-0.18)	0.02 (0.00-0.14)	0.02 (0.00-0.14)	0.02 (0.00-0.14)	0.36 (0.22-0.57)	0.02 (0.00-0.14)
Proximal humeral hemiarthroplasty	18	9.8	1.83 (1.15-2.90)	0.10 (0.01-0.72)	0	0.30 (0.10-0.94)	0.10 (0.01-0.72)	0.10 (0.01-0.72)	0	0.10 (0.01-0.72)	0.30 (0.10-0.94)	0.10 (0.01-0.72)
Total shoulder replacement	0	0.1	0	0	0	0	0	0	0	0	0	0
Reverse polarity total shoulder replacement	36	34.7	1.04 (0.75-1.44)	0.03 (0.00-0.20)	0.03 (0.00-0.20)	0	0.06 (0.01-0.23)	0	0.03 (0.00-0.20)	0	0.40 (0.24-0.68)	0
Unconfirmed	8	5.8	1.38 (0.69-2.76)	0	0	0	0	0	0	0	0.17 (0.02-1.23)	0

Note: Suppressed due to zero events: Impingement, Glenoid implant wear, Lysis humerus.

Table 3.S12 PTIR estimates of indications for shoulder revision (95% CI) for elective procedures by type of shoulder replacement between 2012 and 2021.

Elective	Events N	Prosthesis-years at risk (x100)	Number of revisions per 100 prosthesis-years at risk for: All causes	Infection	Instability | Dislocation	Cuff insufficiency	Aseptic loosening | Lysis	Peri-prosthetic fracture	Other indications
All cases	**1,840**	**2,118.7**	**0.87 (0.83-0.91)**	**0.12 (0.11-0.14)**	**0.22 (0.20-0.24)**	**0.21 (0.19-0.23)**	**0.11 (0.10-0.13)**	**0.05 (0.04-0.06)**	**0.12 (0.11-0.14)**
Proximal humeral hemiarthroplasty	**500**	**355.8**	**1.41 (1.29-1.53)**	**0.07 (0.05-0.11)**	**0.11 (0.08-0.15)**	**0.47 (0.41-0.55)**	**0.10 (0.07-0.13)**	**0.02 (0.01-0.04)**	**0.41 (0.35-0.48)**
Resurfacing	255	174.3	1.46 (1.29-1.65)	0.07 (0.04-0.12)	0.08 (0.05-0.14)	0.50 (0.40-0.62)	0.11 (0.07-0.17)	0.03 (0.02-0.08)	0.41 (0.33-0.52)
Stemless	96	60.1	1.60 (1.31-1.95)	0.05 (0.02-0.15)	0.08 (0.03-0.20)	0.53 (0.38-0.75)	0.07 (0.02-0.18)	0.02 (0.00-0.12)	0.55 (0.39-0.77)
Stemmed	149	121.5	1.23 (1.04-1.44)	0.09 (0.05-0.16)	0.16 (0.10-0.25)	0.41 (0.31-0.54)	0.09 (0.05-0.16)	0	0.34 (0.25-0.46)
Total shoulder replacement	**476**	**670.0**	**0.71 (0.65-0.78)**	**0.06 (0.04-0.08)**	**0.23 (0.20-0.27)**	**0.34 (0.30-0.39)**	**0.12 (0.10-0.15)**	**0.02 (0.01-0.04)**	**0.10 (0.08-0.13)**
Resurfacing	20	29.9	0.67 (0.43-1.04)	0.03 (0.00-0.24)	0.13 (0.05-0.36)	0.33 (0.18-0.62)	0.03 (0.00-0.24)	0.03 (0.00-0.24)	0.10 (0.03-0.31)
Stemless	141	216.3	0.65 (0.55-0.77)	0.06 (0.03-0.10)	0.23 (0.17-0.30)	0.30 (0.24-0.38)	0.10 (0.06-0.15)	0.03 (0.01-0.06)	0.10 (0.06-0.15)
Stemmed	315	423.8	0.74 (0.67-0.83)	0.05 (0.04-0.08)	0.24 (0.20-0.29)	0.36 (0.31-0.43)	0.14 (0.11-0.18)	0.02 (0.01-0.04)	0.10 (0.08-0.14)
Reverse polarity total shoulder replacement	**621**	**875.1**	**0.71 (0.66-0.77)**	**0.18 (0.16-0.21)**	**0.25 (0.22-0.29)**	**0.01 (0.01-0.02)**	**0.10 (0.08-0.12)**	**0.07 (0.05-0.09)**	**0.03 (0.02-0.05)**
Stemless	13	7.9	1.64 (0.95-2.82)	0.25 (0.06-1.01)	0.25 (0.06-1.01)	0.13 (0.02-0.89)	0.63 (0.26-1.51)	0.13 (0.02-0.89)	0
Stemmed	608	867.2	0.70 (0.65-0.76)	0.18 (0.15-0.21)	0.25 (0.22-0.29)	0.01 (0.01-0.02)	0.09 (0.07-0.11)	0.07 (0.05-0.09)	0.03 (0.02-0.05)
Interpositional arthroplasty	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Unconfirmed	**243**	**217.6**	**1.12 (0.98-1.27)**	**0.16 (0.12-0.22)**	**0.25 (0.19-0.33)**	**0.19 (0.14-0.26)**	**0.17 (0.13-0.24)**	**0.09 (0.06-0.14)**	**0.08 (0.05-0.13)**
Unconfirmed HHA	22	14.9	1.47 (0.97-2.24)	0.20 (0.06-0.62)	0.07 (0.01-0.48)	0.47 (0.22-0.98)	0.13 (0.03-0.54)	0.13 (0.03-0.54)	0.20 (0.06-0.62)
Unconfirmed TSR	120	103.2	1.16 (0.97-1.39)	0.07 (0.03-0.14)	0.19 (0.12-0.30)	0.30 (0.21-0.43)	0.21 (0.14-0.32)	0.04 (0.01-0.10)	0.12 (0.07-0.20)
Unconfirmed RTSR	101	99.3	1.02 (0.84-1.24)	0.25 (0.17-0.37)	0.34 (0.24-0.48)	0.04 (0.02-0.11)	0.14 (0.08-0.24)	0.13 (0.08-0.23)	0.02 (0.01-0.08)
Unconfirmed IPA	0	0.1	0	0	0	0	0	0	0

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S13 PTIR estimates of indications for shoulder revision (95% CI) for elective procedures by type of shoulder replacement using reports from MDSv7.

Elective	Events N	Prosthesis-years at risk (x100)	Number of revisions per 100 prosthesis-years at risk for: All causes	Aseptic loosening humerus	Aseptic loosening glenoid	Stiffness	Impingement	Component dissociation	Glenoid implant wear	Native glenoid surface erosion	Implant fracture	Dislocation	Unexplained pain
All cases	341	37.8	9.03 (8.12-10.04)	0.16 (0.07-0.35)	0.74 (0.51-1.07)	0.16 (0.07-0.35)	0.19 (0.09-0.39)	0.79 (0.56-1.14)	0.16 (0.07-0.35)	0.42 (0.26-0.69)	0.05 (0.01-0.21)	1.35 (1.03-1.78)	0.40 (0.24-0.66)
Proximal humeral hemiarthroplasty	39	2.8	13.97 (10.20-19.12)	0.36 (0.05-2.54)	0	1.43 (0.54-3.82)	0	0.36 (0.05-2.54)	0.36 (0.05-2.54)	5.37 (3.24-8.91)	0	2.15 (0.97-4.78)	2.15 (0.97-4.78)
Resurfacing	10	0.8	13.27 (7.14-24.66)	0	0	2.65 (0.66-10.61)	0	0	1.33 (0.19-9.42)	6.63 (2.76-15.94)	0	0	5.31 (1.99-14.14)
Stemless	8	0.9	8.70 (4.35-17.39)	0	0	0	0	0	0	2.17 (0.54-8.70)	0	0	1.09 (0.15-7.72)
Stemmed	21	1.1	18.76 (12.23-28.78)	0.89 (0.13-6.34)	0	1.79 (0.45-7.15)	0	0.89 (0.13-6.34)	0	7.15 (3.57-14.29)	0	5.36 (2.41-11.93)	0.89 (0.13-6.34)
Total shoulder replacement	66	10.8	6.10 (4.79-7.77)	0	0.92 (0.50-1.72)	0.18 (0.05-0.74)	0.18 (0.05-0.74)	0.37 (0.14-0.99)	0.28 (0.09-0.86)	0.09 (0.01-0.66)	0	0.83 (0.43-1.60)	0.28 (0.09-0.86)
Resurfacing	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Stemless	32	5.2	6.19 (4.38-8.76)	0	0.77 (0.29-2.06)	0	0	0.58 (0.19-1.80)	0.19 (0.03-1.37)	0	0	0.58 (0.19-1.80)	0.19 (0.03-1.37)
Stemmed	34	5.5	6.14 (4.39-8.59)	0	1.08 (0.49-2.41)	0.36 (0.09-1.44)	0.36 (0.09-1.44)	0.18 (0.03-1.28)	0.36 (0.09-1.44)	0.18 (0.03-1.28)	0	1.08 (0.49-2.41)	0.36 (0.09-1.44)
Reverse polarity total shoulder replacement	190	21.1	9.00 (7.81-10.37)	0.19 (0.07-0.50)	0.76 (0.46-1.24)	0	0.24 (0.10-0.57)	0.99 (0.65-1.53)	0.05 (0.01-0.34)	0	0.09 (0.02-0.38)	1.47 (1.03-2.09)	0.28 (0.13-0.63)
Stemless	<4	0.2	12.01 (3.00-48.02)	6.01 (0.85-42.63)	6.01 (0.85-42.63)	0	0	0	0	0	0	0	0
Stemmed	188	20.9	8.97 (7.78-10.35)	0.14 (0.05-0.44)	0.72 (0.43-1.19)	0	0.24 (0.10-0.57)	1.00 (0.65-1.54)	0.05 (0.01-0.34)	0	0.10 (0.02-0.38)	1.48 (1.04-2.10)	0.29 (0.13-0.64)
Interpositional arthroplasty	0	0.0	0	0	0	0	0	0	0	0	0	0	0
Unconfirmed	46	3.0	15.15 (11.35-20.23)	0.33 (0.05-2.34)	0.66 (0.16-2.63)	0	0	1.32 (0.49-3.51)	0.33 (0.05-2.34)	0	0	1.65 (0.69-3.96)	0
Unconfirmed HHA	4	0.2	18.43 (6.92-49.11)	0	0	0	0	0	4.61 (0.65-32.71)	0	0	0	0
Unconfirmed TSR	6	0.7	8.68 (3.90-19.32)	0	0	0	0	1.45 (0.20-10.27)	0	0	0	0	0
Unconfirmed RTSR	36	2.1	17.01 (12.27-23.58)	0.47 (0.07-3.35)	0.94 (0.24-3.78)	0	0	1.42 (0.46-4.40)	0	0	0	2.36 (0.98-5.68)	0
Unconfirmed IPA	0	0.0	0	0	0	0	0	0	0	0	0	0	0

Note: Suppressed due to zero events: Lysis humerus, Lysis glenoid.
Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S12 and Table 3.S13 (pages 286 and 287) describe the prosthesis time incidence rate (PTIR) per 100 years of follow-up for the reported indication for revision in elective patients receiving a primary shoulder replacement by type and sub-type of shoulder replacement.

Table 3.S12 reports indications for all patients across the life of the registry i.e. between 2012 and 2021. This was achieved by aggregating indications for revision across the different minimum datasets. Table 3.S13 reports data for patients whose information was entered following the introduction of MDSv7.

We have shown that cuff insufficiency is the leading indication for revision for those who receive a proximal humeral hemiarthroplasty or conventional total shoulder replacement, whereas instability or dislocation and infection are the leading causes in reverse polarity total shoulder replacements, see Table 3.S12. The low number of primary replacements and even lower frequency of revisions for patients whose data were entered using the most recent minimum dataset makes results difficult to interpret. It is important to note the indications for revision are not mutually exclusive and 20.3%, 65.7%, and 11.7% recorded none, one and two indications for revision respectively.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed, and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

3.6.3 Patient Reported Outcome Measures (PROMs) Oxford Shoulder Scores (OSS) associated with primary shoulder replacement surgery

The Oxford Shoulder Score (OSS) is a validated patient reported outcome measure for use in shoulder surgery. It consists of 12 pain and function items which address problems that the patient may have encountered with their shoulder over the preceding four weeks (Dawson et al., 1996). The score is coded from 0 to 4 (from 'worst' to 'best') and then summed in line with updated OSS recommendations (Dawson et al., 2009). The final total score ranges from 0 to 48, with 48 representing the 'best' outcome and 0 the 'worst'. Where up to two items were missing, the average of the remaining items can be substituted for the missing values (Dawson et al., 2009). If more than two items were missing, the results have to be disregarded.

Dawson J, Fitzpatrick R, Carr A, JBJS, 1996: 78-B, 593-600.
Dawson J, Rogers K, Fitzpatrick R and Carr A, Arch Orthop Trauma Surg, 2009, 129:119-123.

Table 3.S14 Number and percentage of patients who completed an Oxford Shoulder Score (OSS) by acute trauma and elective indications, by the collection window of interest at different time points.

		Pre-operative OSS			6 Month OSS			3 Year OSS			5 Year OSS		
		N	Eligible (%)	Responders (%)	N	Eligible (%)	Responders (%)	N	Eligible (%)	Responders (%)	N	Eligible (%)	Responders (%)
Acute trauma	All eligible cases	6,108	(100.0)		5,553	(100.0)		3,205	(100.0)		1,656	(100.0)	
	All responders	550	(9.0)	(100.0)	2,224	(40.1)	(100.0)	256	(8.0)	(100.0)	340	(20.5)	(100.0)
	All complete* within window of interest	401	(6.6)	(72.9)	1,624	(29.2)	(73.0)	249	(7.8)	(97.3)	335	(20.2)	(98.5)
	OSS collected before window of interest	<4	(<0.1)	(0.4)	4	(0.1)	(0.2)	<4	(<0.1)	(0.4)	<4	(0.1)	(0.3)
	1 to 9 Items completed	<4	(<0.1)	(0.2)	0	(0)	(0)	0	(0)	(0)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	0	(0)	(0)	<4	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)	<4	(0.1)	(0.3)
	12 Items completed	<4	(<0.1)	(0.2)	<4	(0.1)	(0.1)	<4	(<0.1)	(0.4)	0	(<0.1)	(<0.1)
	OSS collected within window of interest	411	(6.7)	(74.7)	1,635	(29.4)	(73.5)	253	(7.9)	(98.8)	337	(20.4)	(99.1)
	1 to 9 Items completed	10	(0.2)	(1.8)	11	(0.2)	(0.5)	4	(0.1)	(1.6)	<4	(0.1)	(0.6)
	10 to 11 Items completed	23	(0.4)	(4.2)	93	(1.7)	(4.2)	6	(0.2)	(2.3)	10	(0.6)	(2.9)
	12 Items completed	378	(6.2)	(68.7)	1,531	(27.6)	(68.8)	243	(7.6)	(94.9)	325	(19.6)	(95.6)
	OSS collected after window of interest	137	(2.2)	(24.9)	562	(10.1)	(25.3)	<4	(0.1)	(0.8)	<4	(0.1)	(0.6)
	1 to 9 Items completed	22	(0.4)	(4.0)	<4	(0.1)	(0.1)	0	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	8	(0.1)	(1.5)	38	(0.7)	(1.7)	0	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)
	12 Items completed	107	(1.8)	(19.5)	521	(9.4)	(23.4)	<4	(0.1)	(0.8)	<4	(0.1)	(0.6)
Elective	All eligible cases	50,204	(100.0)		47,328	(100.0)		33,216	(100.0)		19,688	(100.0)	
	All responders	18,379	(36.6)	(100.0)	22,743	(48.1)	(100.0)	3,045	(9.2)	(100.0)	4,408	(22.4)	(100.0)
	All complete* within window of interest	12,657	(25.2)	(68.9)	15,855	(33.5)	(69.7)	2,989	(9.0)	(98.2)	4,333	(22.0)	(98.3)
	OSS collected before window of interest	1,093	(2.2)	(5.9)	117	(0.2)	(0.5)	7	(<0.1)	(0.2)	15	(0.1)	(0.3)
	1 to 9 Items completed	5	(<0.1)	(<0.1)	<4	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	25	(<0.1)	(0.1)	10	(<0.1)	(<0.1)	<4	(<0.1)	(<0.1)	<4	(<0.1)	(<0.1)
	12 Items completed	1,063	(2.1)	(5.8)	106	(0.2)	(0.5)	6	(<0.1)	(0.2)	14	(0.1)	(0.3)
	OSS collected within window of interest	12,724	(25.3)	(69.2)	15,961	(33.7)	(70.2)	3,018	(9.1)	(99.1)	4,381	(22.3)	(99.4)
	1 to 9 Items completed	67	(0.1)	(0.4)	106	(0.2)	(0.5)	29	(0.1)	(1.0)	48	(0.2)	(1.1)
	10 to 11 Items completed	500	(1.0)	(2.7)	908	(1.9)	(4.0)	212	(0.6)	(7.0)	288	(1.5)	(6.5)
	12 Items completed	12,157	(24.2)	(66.1)	14,947	(31.6)	(65.7)	2,777	(8.4)	(91.2)	4,045	(20.5)	(91.8)
	OSS collected after window of interest	4,562	(9.1)	(24.8)	6,472	(13.7)	(28.5)	20	(0.1)	(0.7)	12	(0.1)	(0.3)
	1 to 9 Items completed	135	(0.3)	(0.7)	46	(0.1)	(0.2)	0	(<0.1)	(<0.1)	<4	(<0.1)	(<0.1)
	10 to 11 Items completed	380	(0.8)	(2.1)	348	(0.7)	(1.5)	0	(<0.1)	(<0.1)	<4	(<0.1)	(0.1)
	12 Items completed	4,047	(8.1)	(22.0)	6,078	(12.8)	(26.7)	20	(0.1)	(0.7)	8	(<0.1)	(0.2)

*Complete corresponds to ten or more items completed.
Note: The windows of interest are: Pre-operative[-90 to 0 days], 6 months [5 to 8 months], 3 years [2 years 11 months to 3 years 6 months], 5 years [4 years 11 months to 5 years 6 months].

Table 3.S14 (page 289) provides a detailed description of the number of patients reporting an OSS pre-operatively, 6 months, 3 years and 5 years following surgery for patients undergoing primary shoulder replacement for acute trauma or elective indications. The responses are further divided by how close to the time point of interest it was collected and the completeness of each PROMs questionnaire. The results are expressed absolutely (N) and as a percentage (%) of 'Eligible' participants and those who 'Responded' to the PROMs. Eligibility is defined as being alive at the time point of interest and also having sufficient follow-up time following primary surgery.

How close the response was to the time point of interest is categorised by defining 'windows of interest'. The pre-operative window of interest is 90 days prior to the primary surgery until the day of the primary operation. The 6-month data collection window of interest ranges from 5 months to 8 months, i.e. spanning a 3-month window of interest. The 3- and 5-year data collections had windows of interest ranging from 1 month prior to 3 and 5 years respectively to 6 months after i.e. spanning a 7-month window of interest.

Ensuring data is collected pre-operatively by hospital trusts is very important. In order to assess the efficacy of a surgical technique or implantable construct, understanding where the patient started is critical in order to understand how the patient is likely to respond to surgery. Collecting a pre-operative PROM post-operatively is likely to induce recall bias and for this reason the end of the pre-operative window was strictly defined as the day of surgery. Table 3.S14 clearly illustrates only a small minority of eligible patients complete an OSS questionnaire prior to surgery and within the window of interest.

Given the low compliance in pre-operative score collection by hospitals delivering shoulder replacement surgery, the potential for bias in interpreting results is clear. Collection and compliance with reporting at 6 months, 3 and 5 years is substantially better than pre-operative rates, but the response rate of all eligible participants is still less than 50% in all instances. The British Elbow and Shoulder Society (BESS) have deemed shoulder PROMs essential in the assessment of patient outcomes and surveillance after shoulder replacement surgery. The low pre-operative compliance with PROMs data collection by hospital trusts is therefore particularly concerning.

Table 3.S15 Number and percentage of patients who, cross-sectionally, completed Oxford Shoulder Score (OSS) by overall, acute trauma, elective and by year of primary operation, within the collection window of interest, with valid measurements at the time points of interest.

	Year of primary	Potential cases N	OSS completed at: Pre-op N (% of Pre-op)	6 month N (% of Pre-op)	3 year N (% of Pre-op)	5 year N (% of Pre-op)
Acute trauma & elective	All years	56,312	13,058 (23.2)	17,479 (33.1)	3,238 (8.9)	4,668 (21.9)
	2012	2,556	671 (26.3)	344 (13.6)	0 (0)	1,129 (51.2)
	2013	4,422	1,077 (24.4)	1,883 (43.0)	0 (0)	1,355 (35.4)
	2014	5,317	1,415 (26.6)	298 (5.6)	2,067 (41.6)	1,839 (39.8)
	2015	5,744	1,489 (25.9)	857 (15.0)	729 (13.6)	345 (6.9)
	2016	6,538	1,475 (22.6)	26 (0.4)	263 (4.3)	0 (0)
	2017	7,009	1,486 (21.2)	4,672 (67.3)	179 (2.7)	0
	2018	7,261	1,429 (19.7)	5,007 (69.5)	0 (0)	0
	2019	7,804	1,794 (23.0)	4,127 (53.3)	0	0
	2020	4,132	962 (23.3)	265 (6.5)	0	0
	2021	5,529	1,260 (22.8)	0 (0)	0	0
Acute trauma	All years	6,108	401 (6.6)	1,624 (29.2)	249 (7.8)	335 (20.2)
	2012	162	11 (6.8)	17 (10.9)	0 (0)	52 (40.6)
	2013	387	42 (10.9)	149 (39.4)	0 (0)	100 (33.3)
	2014	474	36 (7.6)	33 (7.2)	162 (40.7)	145 (42.2)
	2015	535	31 (5.8)	92 (17.6)	76 (16.3)	38 (9.3)
	2016	598	41 (6.9)	7 (1.2)	9 (1.7)	0 (0)
	2017	716	35 (4.9)	441 (63.1)	<4 (0.3)	0
	2018	768	50 (6.5)	469 (62.0)	0 (0)	0
	2019	896	54 (6.0)	401 (45.7)	0	0
	2020	720	49 (6.8)	15 (2.1)	0	0
	2021	852	52 (6.1)	0 (0)	0	0
Elective	All years	50,204	12,657 (25.2)	15,855 (33.5)	2,989 (9.0)	4,333 (22.0)
	2012	2,394	660 (27.6)	327 (13.8)	0 (0)	1,077 (51.9)
	2013	4,035	1,035 (25.7)	1,734 (43.3)	0 (0)	1,255 (35.6)
	2014	4,843	1,379 (28.5)	265 (5.5)	1,905 (41.7)	1,694 (39.7)
	2015	5,209	1,458 (28.0)	765 (14.8)	653 (13.3)	307 (6.7)
	2016	5,940	1,434 (24.1)	19 (0.3)	254 (4.5)	0 (0)
	2017	6,293	1,451 (23.1)	4,231 (67.8)	177 (3.0)	0
	2018	6,493	1,379 (21.2)	4,538 (70.4)	0 (0)	0
	2019	6,908	1,740 (25.2)	3,726 (54.3)	0	0
	2020	3,412	913 (26.8)	250 (7.4)	0	0
	2021	4,677	1,208 (25.8)	0 (0)	0	0

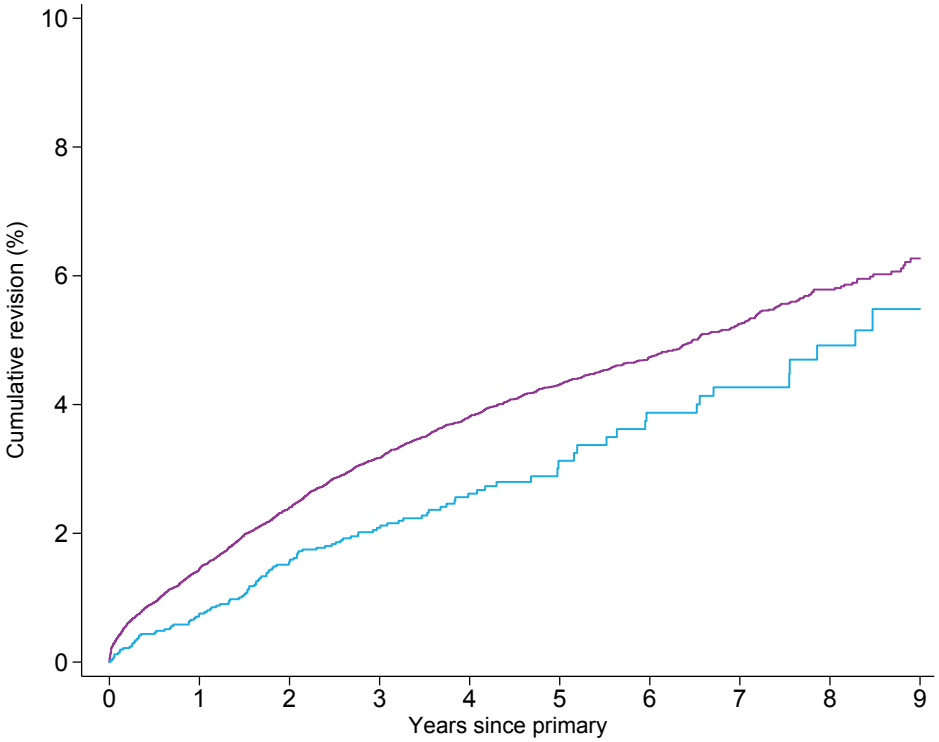
Table 3.S15 provides a detailed description of the number of patients reporting complete OSS within the window of interest pre-operatively and at 6 months, 3 years and 5 years by the year of surgery for patients undergoing primary shoulder replacement for acute trauma or elective indications. The denominator used to calculate percentages is the number of patients alive at the milestone of interest. Where numbers appear without a percentage in parentheses, the PROMs were collected prior to the target date but within the window of interest. The data illustrates that collection and submission of pre-operative PROMs by hospitals is consistently poor, with less than 30% of elective patients having had PROMs data submitted. In recent years the compliance with 6-month reporting has steadily improved.

Table 3.S16 Number and percentage of patients who completed longitudinal Oxford Shoulder Score (OSS) by overall, acute trauma, elective and by year of primary operation, within the collection window of interest, with valid measurements at the time points of interest.

	Year of primary	Potential cases N	OSS completed at:					
			Pre-op	Pre-op, 6m	Pre-op, 3y	Pre-op, 5y	Pre-op, 6m, 3y	Pre-op, 6m, 3y, 5y
			N	N (% of Pre-op)	N (% of Pre-op)	N (% of Pre-op)	N (% of Pre-op)	N (% of Pre-op)
Acute trauma & elective	All years	56,312	13,058	4,232 (32.4)	1,141 (8.7)	1,371 (10.5)	355 (2.7)	118 (0.9)
	2012	2,556	671	91 (13.6)	0 (0)	344 (51.3)	0 (0)	0 (0)
	2013	4,422	1,077	527 (48.9)	0 (0)	369 (34.3)	0 (0)	0 (0)
	2014	5,317	1,415	83 (5.9)	614 (43.4)	561 (39.6)	62 (4.4)	49 (3.5)
	2015	5,744	1,489	239 (16.1)	201 (13.5)	97 (6.5)	185 (12.4)	69 (4.6)
	2016	6,538	1,475	5 (0.3)	197 (13.4)	0 (0)	<4 (0.2)	0 (0)
	2017	7,009	1,486	1,048 (70.5)	129 (8.7)	0 (0)	105 (7.1)	0 (0)
	2018	7,261	1,429	1,052 (73.6)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	7,804	1,794	951 (53.0)	0 (0)	0 (0)	0 (0)	0 (0)
	2020	4,132	962	236 (24.5)	0 (0)	0 (0)	0 (0)	0 (0)
	2021	5,529	1,260	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Acute trauma	All years	6,108	401	120 (29.9)	25 (6.2)	29 (7.2)	<4 (0.5)	<4 (0.2)
	2012	162	11	<4 (9.1)	0 (0)	4 (36.4)	0 (0)	0 (0)
	2013	387	42	17 (40.5)	0 (0)	13 (31.0)	0 (0)	0 (0)
	2014	474	36	<4 (2.8)	14 (38.9)	11 (30.6)	0 (0)	0 (0)
	2015	535	31	<4 (9.7)	<4 (6.5)	<4 (3.2)	<4 (3.2)	<4 (3.2)
	2016	598	41	0 (0)	7 (17.1)	0 (0)	0 (0)	0 (0)
	2017	716	35	21 (60.0)	<4 (5.7)	0 (0)	<4(2.9)	0 (0)
	2018	768	50	33 (66.0)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	896	54	29 (53.7)	0 (0)	0 (0)	0 (0)	0 (0)
	2020	720	49	15 (30.6)	0 (0)	0 (0)	0 (0)	0 (0)
	2021	852	52	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Elective	All years	50,204	12,657	4,112 (32.5)	1,116 (8.8)	1,342 (10.6)	353 (2.8)	117 (0.9)
	2012	2,394	660	90 (13.6)	0 (0)	340 (51.5)	0 (0)	0 (0)
	2013	4,035	1,035	510 (49.3)	0 (0)	356 (34.4)	0 (0)	0 (0)
	2014	4,843	1,379	82 (5.9)	600 (43.5)	550 (39.9)	62 (4.5)	49 (3.6)
	2015	5,209	1,458	236 (16.2)	199 (13.6)	96 (6.6)	184 (12.6)	68 (4.7)
	2016	5,940	1,434	5 (0.3)	190 (13.2)	0 (0)	<4 (0.2)	0 (0)
	2017	6,293	1,451	1,027 (70.8)	127 (8.8)	0 (0)	104 (7.2)	0 (0)
	2018	6,493	1,379	1,019 (73.9)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	6,908	1,740	922 (53.0)	0 (0)	0 (0)	0 (0)	0 (0)
	2020	3,412	913	221 (24.2)	0 (0)	0 (0)	0 (0)	0 (0)
	2021	4,677	1,208	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Table 3.S16 describes the number and percentage of paired measurements available for longitudinal analyses for all patients undergoing primary shoulder replacement for acute trauma or elective indications. The denominator used to calculate percentages is the number of pre-operative measurements. The numerator is the number of responses within the window of interest, see Table 3.S14 (page 289), with no more than two items missing responses. The proportion of patients available for a paired longitudinal analysis at any time point is low, and the proportion of patients with serial measurements at any time point is even lower. While the proportion of patients with pre-operative and 6-month OSS has increased in recent years, this still only represents 14.5% of all eligible primary replacements.

Figure 3.S7 KM estimates of cumulative revision for primary elective shoulder replacements for patients with and without valid PROMs. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
Non PROMs cohort	46,092	40,230	36,038	29,348	23,360	17,944	12,323	7,861	4,012	1,458
PROMs cohort	4,112	4,060	3,756	2,798	1,779	801	758	527	427	*65*

Figure 3.S7 reports the cumulative revision rate for elective patients undergoing primary shoulder replacements who completed pre-operative and 6-month PROMs assessments within the specified window of interest. Results indicate a different cumulative revision rate for patients who are included in the PROMs cohort versus those who are not. This difference suggests the group of patients responding to the PROMs questionnaires are different from those who are not responding and so are not representative of the larger population. This highlights the risk of using incomplete datasets to make inferences for the larger cohort and this PROMs data needs to be interpreted cautiously despite its relatively large size. If anything it indicates that the PROMs cohort is likely to be a more 'satisfied' group of patients as their revision rates are lower than the non-PROMs cohort.

Figure 3.S8 Distribution and scatter of pre-operative Oxford Shoulder Score (OSS) and the change in OSS (post-pre) score for those receiving elective shoulder replacements for valid measurements within the collection window of interest.

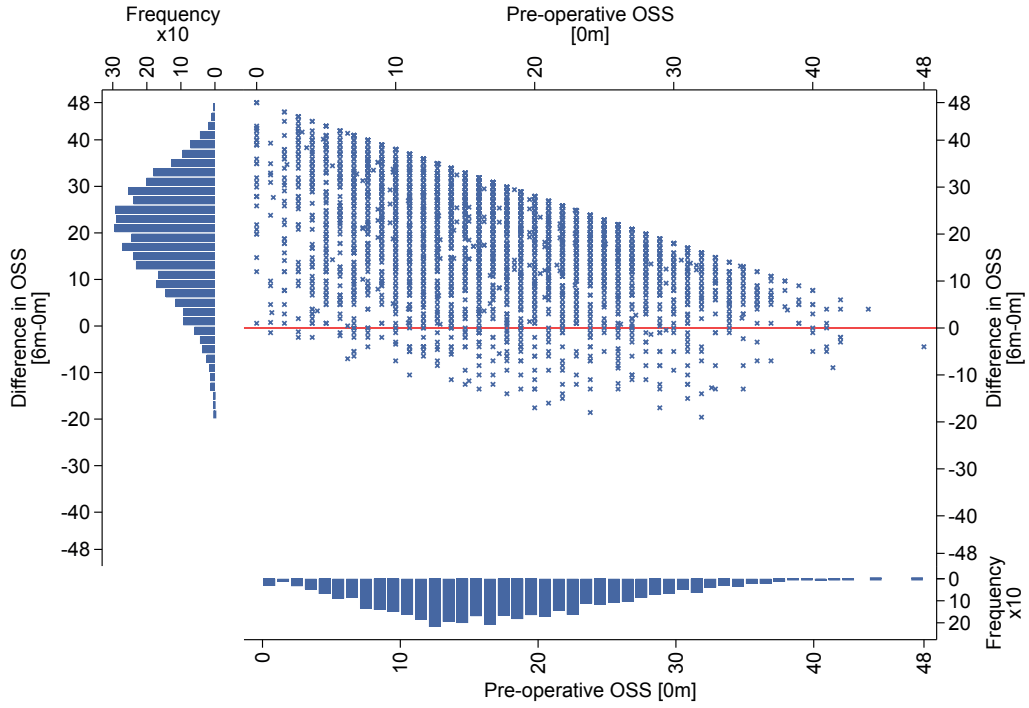


Figure 3.S8 illustrates the distribution of pre-operative OSS and change in OSS between the pre-operative and the 6-month assessment. Results are displayed for patients with elective indications for primary shoulder replacement only. It also illustrates the association between pre-operative OSS and the change in OSS. While pre-operative and change in OSS are approximately normally distributed, this hides the profound ceiling effect within the assessment of the change score. This makes the interpretation of change in OSS particularly challenging and highlights the necessity of ascertaining a pre-operative PROMs when assessing the efficacy of any intervention associated with a primary shoulder replacement. In the absence of specialist methods which account for floor and ceiling effects, a simple analysis of change scores is reported to be the most appropriate (Glymour et al., 2005). At six months following surgery, 5.3% of patients reported a score worse than they did pre-operatively. This figure is reduced compared to previous years due to the more refined inclusion/exclusion criteria of the PROMs cohort as defined previously.

Glymour M., et al. American Journal of Epidemiology, 2005: 162(3), 267-278.

Table 3.S17 Descriptive statistics of the pre-operative, 6 month and the change in Oxford Shoulder Score (OSS) by overall, acute trauma, elective and by year of primary operation, within the collection window of interest, with valid measurements pre-operatively and 6 months post-operatively.

	Year of primary	Complete cases N	OSS [0 min, 48 max]					
			Pre-op		6 month		(6 month - Pre-op)	
			Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th
Acute trauma & elective	All years	4,232	16.7 (8.5)	[11, 16, 22]	35.8 (10.5)	[30, 39, 44]	19.0 (11.6)	[12, 20, 27]
	2012	91	17.6 (7.9)	[12, 16, 23]	33.8 (11.8)	[28, 37, 43]	16.2 (11.7)	[8, 16, 25]
	2013	527	17.5 (8.6)	[11, 17, 23]	33.8 (10.7)	[27, 36, 43]	16.3 (12.0)	[8, 17, 25]
	2014	83	16.2 (8.0)	[10, 15, 22]	34.0 (11.1)	[25, 36, 42]	17.7 (10.2)	[12, 17, 25]
	2015	239	16.0 (7.7)	[11, 15, 21]	33.8 (11.1)	[28, 36, 43]	17.8 (11.0)	[10, 19, 26]
	2016	5	17.4 (9.3)	[9, 18, 26]	42.6 (6.1)	[37, 46, 47]	25.2 (11.4)	[22, 28, 29]
	2017	1,048	16.8 (8.4)	[11, 16, 22]	36.0 (10.2)	[30, 39, 44]	19.2 (11.6)	[12, 20, 28]
	2018	1,052	16.4 (8.6)	[10, 16, 22]	36.2 (10.4)	[30, 39, 44]	19.8 (11.7)	[12, 21, 28]
	2019	951	16.8 (8.5)	[11, 16, 22]	36.6 (10.2)	[31, 40, 44]	19.8 (11.1)	[13, 21, 28]
	2020	236	16.4 (8.8)	[10, 16, 23]	37.3 (9.8)	[33, 40, 44]	20.9 (11.3)	[14, 22, 29]
	2021	0						
Acute trauma	All years	120	12.2 (15.1)	[1, 6, 14]	30.6 (12.0)	[21, 34, 42]	18.4 (19.3)	[8, 22, 32]
	2012	<4						
	2013	17	11.9 (14.7)	[2, 8, 12]	33.3 (13.8)	[25, 41, 44]	21.3 (23.8)	[17, 27, 40]
	2014	<4						
	2015	<4	7.3 (4.9)	[4, 5, 13]	35.0 (11.5)	[22, 39, 44]	27.7 (16.4)	[9, 34, 40]
	2016	0						
	2017	21	15.4 (17.3)	[1, 8, 24]	31.4 (10.7)	[22, 34, 36]	16.0 (21.3)	[3, 22, 27]
	2018	33	16.6 (16.2)	[4, 11, 28]	28.7 (10.8)	[20, 30, 37]	12.1 (19.7)	[-3, 14, 29]
	2019	29	8.6 (13.3)	[0, 2, 12]	31.5 (12.8)	[20, 32, 43]	22.9 (15.9)	[14, 25, 33]
	2020	15	4.7 (9.6)	[0, 1, 4]	28.9 (13.7)	[16, 34, 42]	24.1 (13.2)	[12, 27, 37]
	2021	0						
Elective	All years	4,112	16.8 (8.1)	[11, 16, 22]	35.9 (10.4)	[30, 39, 44]	19.1 (11.3)	[12, 20, 27]
	2012	90	17.3 (7.5)	[12, 16, 22]	33.7 (11.8)	[28, 37, 43]	16.4 (11.6)	[9, 16, 25]
	2013	510	17.7 (8.3)	[11, 17, 23]	33.8 (10.6)	[27, 36, 43]	16.2 (11.4)	[8, 17, 24]
	2014	82	16.3 (8.0)	[10, 15, 22]	34.2 (10.9)	[26, 37, 42]	17.9 (10.2)	[12, 17, 25]
	2015	236	16.1 (7.6)	[11, 16, 21]	33.8 (11.1)	[28, 36, 43]	17.7 (10.9)	[10, 19, 26]
	2016	5	17.4 (9.3)	[9, 18, 26]	42.6 (6.1)	[37, 46, 47]	25.2 (11.4)	[22, 28, 29]
	2017	1,027	16.8 (8.2)	[11, 16, 22]	36.1 (10.2)	[30, 39, 44]	19.2 (11.4)	[12, 20, 28]
	2018	1,019	16.3 (8.2)	[11, 16, 22]	36.4 (10.3)	[31, 39, 44]	20.1 (11.3)	[13, 21, 28]
	2019	922	17.0 (8.1)	[11, 16, 22]	36.7 (10.0)	[31, 40, 44]	19.7 (10.9)	[13, 21, 28]
	2020	221	17.2 (8.1)	[11, 17, 23]	37.9 (9.2)	[34, 41, 44]	20.6 (11.1)	[14, 22, 29]
	2021	0						

Table 3.S17 presents descriptive statistics, mean and standard deviation, median and interquartile range, by year of primary shoulder replacements overall, and by those receiving shoulder replacements for acute trauma or elective indications. Results are presented only for those with measurements pre-operatively and at six months, within the window of interest and with no more than two items missing. The number of patients with valid OSS that receive primary shoulder replacements is relatively low, however, the results appear to be broadly concordant with those receiving primary shoulder replacement for elective indications. The change in OSS has tended to improve across the life of the registry, but the significance of this is very unclear given the potential for bias due to the lack of a representative sample.

Table 3.S18 Descriptive statistics of the pre-operative, 6 month and the change in Oxford Shoulder Score (OSS) by overall, acute trauma, elective and by shoulder type, within the collection window of interest, with valid measurements pre-operatively and 6 months post-operatively.

	Primary procedure	Complete cases N	OSS [0 min, 48 max]					
			Pre-op		6 month		(6 month - Pre-op)	
			Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th
Acute trauma & elective	**Proximal humeral hemiarthroplasty**	**423**	**17.9 (9.3)**	**[11, 17, 23]**	**31.5 (11.8)**	**[23, 34, 41]**	**13.6 (12.4)**	**[6, 14, 23]**
	Resurfacing	192	18.4 (8.4)	[12, 18, 24]	32.4 (11.3)	[26, 35, 41]	14.1 (11.2)	[7, 14, 23]
	Stemless	83	20.0 (8.5)	[16, 19, 23]	33.3 (11.3)	[25, 36, 43]	13.4 (10.7)	[6, 14, 21]
	Stemmed	148	16.0 (10.4)	[9, 14, 22]	29.1 (12.3)	[19, 31, 40]	13.2 (14.6)	[4, 14, 24]
	Total shoulder replacement	**1,341**	**17.7 (8.1)**	**[12, 17, 23]**	**38.6 (9.2)**	**[35, 41, 45]**	**20.9 (10.6)**	**[14, 22, 29]**
	Resurfacing	59	18.8 (8.0)	[12, 19, 24]	39.0 (7.4)	[35, 40, 45]	20.2 (9.5)	[12, 20, 26]
	Stemless	602	18.1 (8.2)	[12, 18, 24]	39.0 (8.9)	[36, 41, 45]	20.9 (10.4)	[14, 22, 29]
	Stemmed	680	17.2 (8.0)	[11, 17, 23]	38.2 (9.6)	[34, 41, 45]	21.0 (10.8)	[14, 21, 29]
	Reverse polarity total shoulder replacement	**2,205**	**15.9 (8.4)**	**[10, 15, 21]**	**35.0 (10.5)**	**[29, 37, 43]**	**19.1 (11.7)**	**[12, 20, 28]**
	Stemless	35	16.8 (6.8)	[10, 17, 22]	35.9 (10.2)	[28, 40, 45]	19.1 (12.4)	[7, 21, 29]
	Stemmed	2,170	15.9 (8.4)	[10, 15, 21]	35.0 (10.5)	[29, 37, 43]	19.1 (11.7)	[12, 20, 28]
	Interpositional arthroplasty	**0**						
	Unconfirmed	**263**	**17.0 (8.8)**	**[10, 17, 24]**	**34.6 (10.3)**	**[28, 36, 43]**	**17.6 (11.2)**	**[10, 18, 25]**
	Unconfirmed HHA	14	17.0 (7.0)	[11, 16, 23]	29.7 (14.6)	[18, 30, 43]	12.7 (14.7)	[4, 12, 23]
	Unconfirmed TSR	117	17.6 (8.8)	[10, 18, 24]	35.7 (10.5)	[29, 39, 44]	18.1 (11.6)	[11, 18, 27]
	Unconfirmed RTSR	132	16.4 (9.1)	[10, 16, 22]	34.2 (9.3)	[28, 36, 41]	17.8 (10.5)	[11, 18, 25]
	Unconfirmed IPA	0						
Acute trauma	**Proximal humeral hemiarthroplasty**	**26**	**15.2 (16.4)**	**[3, 10, 17]**	**27.9 (13.4)**	**[18, 28, 41]**	**12.7 (24.0)**	**[2, 17, 30]**
	Resurfacing	0						
	Stemless	0						
	Stemmed	26	15.2 (16.4)	[3, 10, 17]	27.9 (13.4)	[18, 28, 41]	12.7 (24.0)	[2, 17, 30]
	Total shoulder replacement	**<4**						
	Resurfacing	0						
	Stemless	<4						
	Stemmed	0						
	Reverse polarity total shoulder replacement	**89**	**11.8 (15.0)**	**[1, 5, 13]**	**31.3 (11.7)**	**[22, 34, 42]**	**19.5 (17.8)**	**[9, 23, 33]**
	Stemless	0						
	Stemmed	89	11.8 (15.0)	[1, 5, 13]	31.3 (11.7)	[22, 34, 42]	19.5 (17.8)	[9, 23, 33]
	Interpositional arthroplasty	**0**						
	Unconfirmed	**4**	**1.8 (3.5)**	**[0, 0, 4]**	**29.8 (9.6)**	**[22, 30, 38]**	**28.0 (12.0)**	**[18, 30, 38]**
	Unconfirmed HHA	0						
	Unconfirmed TSR	0						
	Unconfirmed RTSR	4	1.8 (3.5)	[0, 0, 4]	29.8 (9.6)	[22, 30, 38]	28.0 (12.0)	[18, 30, 38]
	Unconfirmed IPA	0						

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S18 (continued)

	Primary procedure	Complete cases N	OSS [0 min, 48 max]					
			Pre-op		6 month		(6 month - Pre-op)	
			Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th
Elective	**Proximal humeral hemiarthroplasty**	**397**	**18.0 (8.6)**	**[12, 18, 23]**	**31.7 (11.7)**	**[24, 34, 41]**	**13.7 (11.3)**	**[6, 14, 22]**
	Resurfacing	192	18.4 (8.4)	[12, 18, 24]	32.4 (11.3)	[26, 35, 41]	14.1 (11.2)	[7, 14, 23]
	Stemless	83	20.0 (8.5)	[16, 19, 23]	33.3 (11.3)	[25, 36, 43]	13.4 (10.7)	[6, 14, 21]
	Stemmed	122	16.2 (8.7)	[10, 15, 22]	29.4 (12.2)	[21, 32, 40]	13.3 (11.9)	[4, 14, 22]
	Total shoulder replacement	**1,340**	**17.7 (8.1)**	**[12, 17, 23]**	**38.6 (9.2)**	**[35, 41, 45]**	**20.9 (10.6)**	**[14, 22, 29]**
	Resurfacing	59	18.8 (8.0)	[12, 19, 24]	39.0 (7.4)	[35, 40, 45]	20.2 (9.5)	[12, 20, 26]
	Stemless	601	18.1 (8.2)	[12, 18, 24]	39.0 (8.9)	[36, 41, 45]	20.9 (10.4)	[14, 22, 29]
	Stemmed	680	17.2 (8.0)	[11, 17, 23]	38.2 (9.6)	[34, 41, 45]	21.0 (10.8)	[14, 21, 29]
	Reverse polarity total shoulder replacement	**2,116**	**16.1 (7.9)**	**[10, 15, 21]**	**35.1 (10.4)**	**[29, 38, 43]**	**19.1 (11.4)**	**[12, 20, 27]**
	Stemless	35	16.8 (6.8)	[10, 17, 22]	35.9 (10.2)	[28, 40, 45]	19.1 (12.4)	[7, 21, 29]
	Stemmed	2,081	16.0 (7.9)	[10, 15, 21]	35.1 (10.4)	[29, 38, 43]	19.1 (11.3)	[12, 20, 27]
	Interpositional arthroplasty	**0**						
	Unconfirmed	**259**	**17.2 (8.7)**	**[11, 17, 24]**	**34.7 (10.3)**	**[28, 36, 43]**	**17.5 (11.2)**	**[10, 18, 25]**
	Unconfirmed HHA	14	17.0 (7.0)	[11, 16, 23]	29.7 (14.6)	[18, 30, 43]	12.7 (14.7)	[4, 12, 23]
	Unconfirmed TSR	117	17.6 (8.8)	[10, 18, 24]	35.7 (10.5)	[29, 39, 44]	18.1 (11.6)	[11, 18, 27]
	Unconfirmed RTSR	128	16.8 (8.8)	[11, 16, 23]	34.3 (9.3)	[28, 36, 42]	17.5 (10.3)	[11, 18, 25]
	Unconfirmed IPA	0						

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S18 (page 296) presents descriptive statistics, mean and standard deviation, median and interquartile range, by type and sub-type of primary shoulder replacements overall, and by those receiving shoulder replacements for acute trauma or elective indications. Results are presented only for those with measurements pre-operatively and at six months, within the window of interest and with no more than two items missing. The number of patients receiving a primary shoulder replacement for acute trauma indications is small.

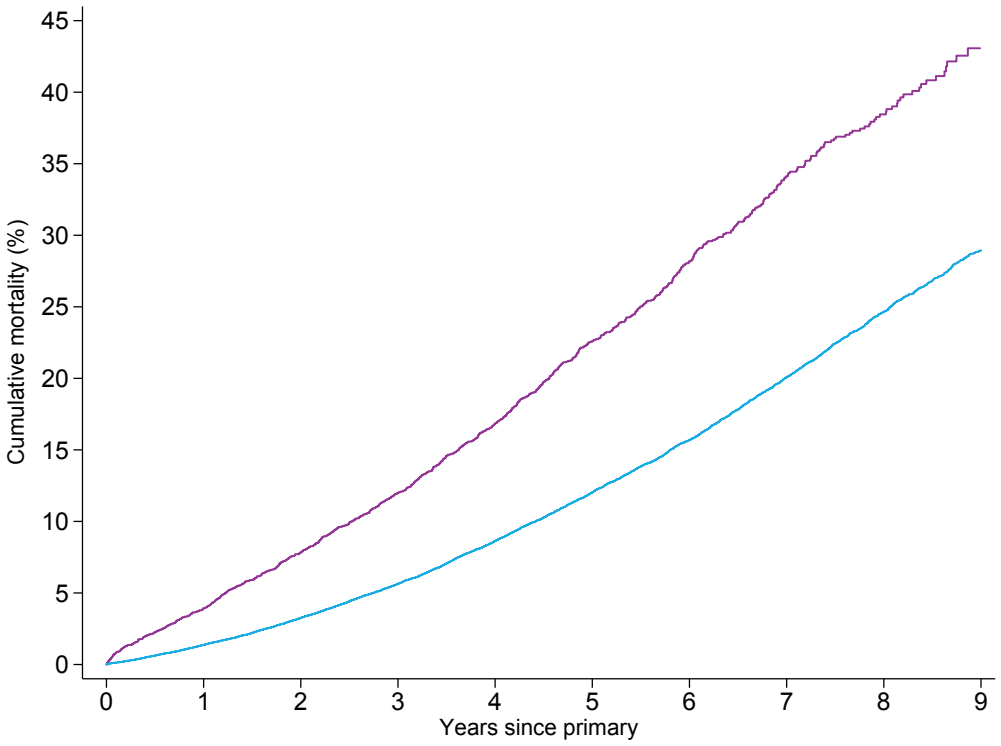
Table 3.S18 clearly illustrates that the change between pre-operative and 6-month assessment of OSS while positive, is still substantially less for patients receiving a proximal humeral hemiarthroplasty compared to either a conventional total or reverse polarity total shoulder replacement. The change in OSS between conventional total shoulder replacement versus reverse polarity total shoulder replacement and sub-type versus type of shoulder replacement is broadly similar.

3.6.4 Mortality after primary shoulder replacement surgery

This following section describes the mortality profile for patients receiving primary shoulder replacements. Where patients received same-day bilateral procedures (N=31), see Figure 3.S1 (page 258), they were excluded from the analysis to avoid double counting. This results in 56,281 patient procedures being included in the analysis, with 7,289 observed deaths.

Figure 3.S9 and Table 3.S19 (page 299) describe the mortality of patients receiving a primary shoulder replacement up to nine years following the primary procedure for all patients (Table 3.S19 only) and patients undergoing surgery for acute trauma and elective indications separately. Data is shown at 30 and 90 days following the primary procedure and then every year until the ninth year. Table 3.S19 indicates the importance of separating the data for patients receiving a primary shoulder replacement for acute trauma from the data for those with elective indications, due to the differences in the frailty of the patient population despite their similar age profile, see Table 3.S2 (page 264).

Figure 3.S9 KM estimates of cumulative mortality by acute trauma and elective indications for patients undergoing primary shoulder replacement. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

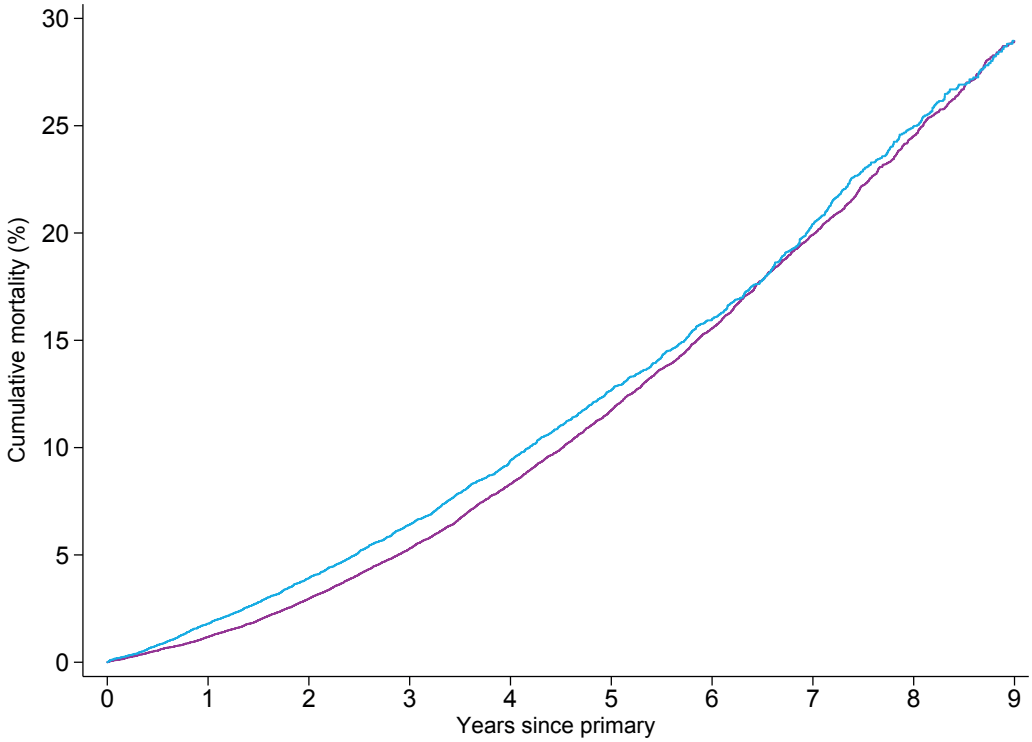


Key:	Numbers at risk									
Acute trauma	6,092	5,032	4,168	3,198	2,374	1,653	1,095	653	341	*84*
Elective	50,189	44,893	40,729	33,207	26,202	19,681	13,828	8,963	4,808	1,674

Table 3.S19 KM estimates of cumulative mortality (95% CI) by acute trauma and elective indications for patients undergoing primary shoulder replacement.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

	N	Age at primary Median (IQR)	Male (%)	Time since primary										
				30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
All cases	56,281	73 (67 to 79)	30	0.19 (0.16-0.23)	0.41 (0.36-0.46)	1.64 (1.53-1.75)	3.73 (3.57-3.90)	6.29 (6.08-6.52)	9.46 (9.18-9.74)	13.06 (12.71-13.41)	16.88 (16.47-17.31)	21.38 (20.87-21.91)	25.93 (25.30-26.58)	30.24 (29.40-31.10)
Acute trauma	6,092	73 (67 to 79)	23	0.74 (0.56-0.99)	1.36 (1.10-1.69)	3.93 (3.46-4.47)	7.84 (7.15-8.60)	12.02 (11.12-12.98)	16.86 (15.75-18.05)	22.60 (21.24-24.04)	28.17 (26.53-29.89)	34.14 (32.16-36.21)	38.45 (36.13-40.87)	*43.07 (40.01-46.27)*
Elective	50,189	73 (67 to 79)	31	0.12 (0.09-0.16)	0.29 (0.25-0.34)	1.37 (1.26-1.47)	3.26 (3.10-3.43)	5.65 (5.43-5.87)	8.64 (8.36-8.93)	12.04 (11.69-12.39)	15.71 (15.28-16.14)	20.08 (19.55-20.62)	24.66 (24.00-25.34)	28.96 (28.08-29.85)

Figure 3.S10 KM estimates of cumulative mortality for primary elective shoulder replacement by gender.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk									
Female	34,754	31,249	28,436	23,232	18,396	13,842	9,775	6,342	3,385	1,181
Male	15,435	13,644	12,293	9,975	7,806	5,839	4,053	2,621	1,423	493

Figure 3.S11 KM estimates of cumulative mortality for primary elective shoulder replacement by age group and gender. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

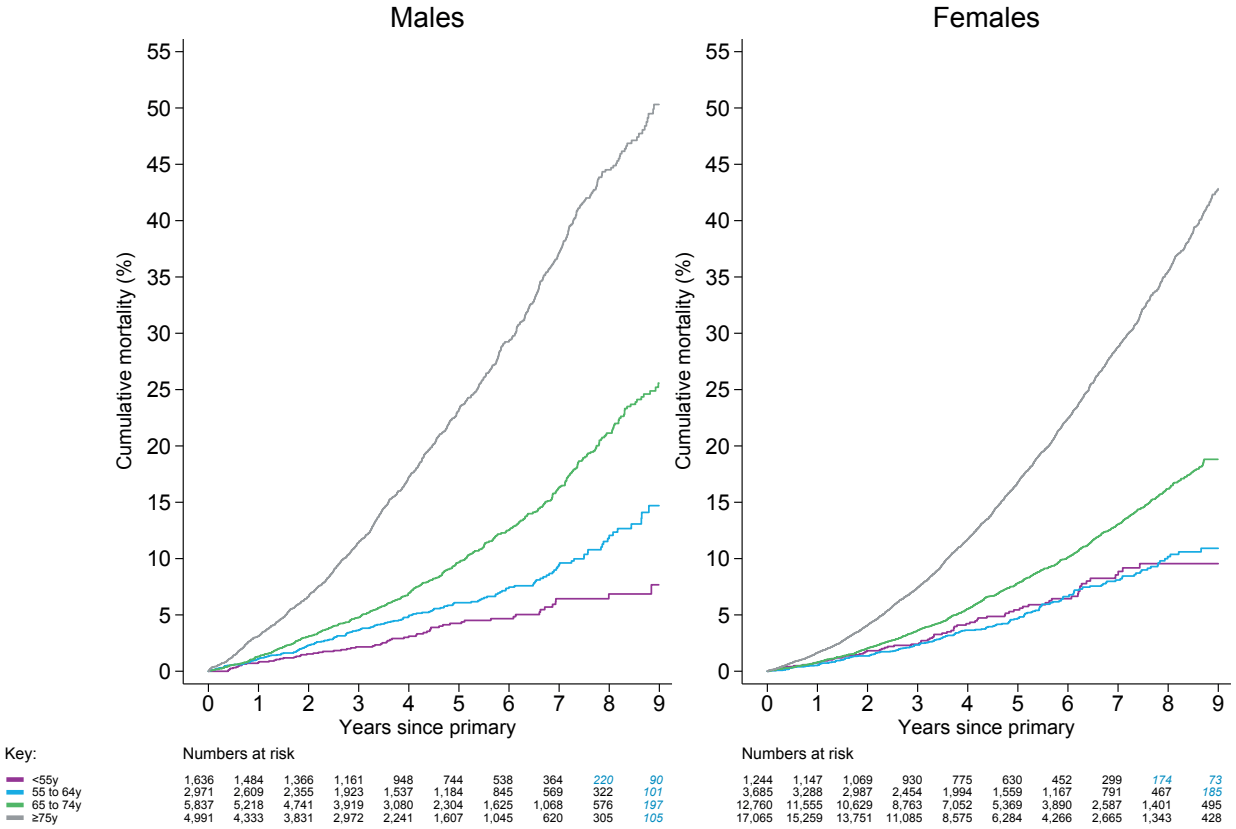


Table 3.S20 KM estimates of cumulative mortality (95% CI) for primary shoulder replacement for elective cases by gender and age group.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Gender	Age at primary (years)	N	Time since primary										
			30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
Female	All	34,754	0.10 (0.07-0.14)	0.26 (0.21-0.32)	1.17 (1.06-1.30)	2.96 (2.78-3.16)	5.31 (5.06-5.57)	8.31 (7.98-8.65)	11.75 (11.33-12.17)	15.56 (15.06-16.09)	19.92 (19.30-20.57)	24.51 (23.73-25.32)	28.94 (27.90-30.02)
	<55	1,244	0.08 (0.01-0.57)	0.24 (0.08-0.75)	0.75 (0.39-1.44)	1.82 (1.19-2.78)	2.40 (1.65-3.49)	4.22 (3.14-5.67)	5.45 (4.16-7.12)	6.44 (4.98-8.32)	8.55 (6.67-10.95)	*9.55 (7.43-12.24)*	*9.55 (7.43-12.24)*
	55 to 64	3,685	0.05 (0.01-0.22)	0.08 (0.03-0.25)	0.52 (0.33-0.82)	1.36 (1.02-1.82)	2.33 (1.85-2.93)	3.65 (3.00-4.42)	4.70 (3.93-5.62)	6.63 (5.62-7.81)	8.10 (6.90-9.49)	10.18 (8.63-11.99)	*10.91 (9.20-12.93)*
	65 to 74	12,760	0.07 (0.04-0.14)	0.20 (0.13-0.29)	0.78 (0.64-0.96)	2.04 (1.79-2.31)	3.64 (3.30-4.01)	5.55 (5.11-6.02)	7.82 (7.27-8.41)	10.12 (9.45-10.84)	13.06 (12.21-13.95)	16.19 (15.12-17.32)	18.81 (17.45-20.27)
	≥75	17,065	0.13 (0.09-0.20)	0.34 (0.27-0.44)	1.64 (1.46-1.85)	4.09 (3.79-4.41)	7.43 (7.01-7.87)	11.71 (11.16-12.29)	16.75 (16.06-17.47)	22.44 (21.59-23.31)	28.77 (27.73-29.85)	35.48 (34.18-36.82)	42.84 (41.03-44.70)
Male	All	15,435	0.17 (0.11-0.25)	0.36 (0.28-0.47)	1.80 (1.59-2.03)	3.93 (3.61-4.26)	6.42 (6.01-6.85)	9.40 (8.88-9.95)	12.70 (12.06-13.37)	16.01 (15.25-16.81)	20.42 (19.46-21.42)	24.99 (23.79-26.24)	28.96 (27.39-30.60)
	<55	1,636	0	0	0.78 (0.44-1.36)	1.54 (1.02-2.30)	2.16 (1.52-3.06)	3.11 (2.29-4.22)	4.25 (3.22-5.60)	4.67 (3.56-6.11)	6.44 (4.91-8.42)	*6.86 (5.18-9.06)*	*7.68 (5.55-10.58)*
	55 to 64	2,971	0.14 (0.05-0.36)	0.31 (0.16-0.59)	1.11 (0.78-1.58)	2.31 (1.80-2.96)	3.67 (3.00-4.50)	4.96 (4.14-5.95)	6.09 (5.12-7.23)	7.47 (6.31-8.84)	9.46 (7.97-11.20)	12.06 (10.08-14.39)	*14.70 (11.97-17.99)*
	65 to 74	5,837	0.07 (0.03-0.18)	0.22 (0.13-0.39)	1.31 (1.04-1.65)	3.10 (2.66-3.60)	4.78 (4.22-5.42)	6.93 (6.22-7.71)	9.66 (8.76-10.64)	12.55 (11.45-13.74)	16.33 (14.93-17.84)	21.14 (19.30-23.12)	*25.58 (23.10-28.28)*
	≥75	4,991	0.36 (0.23-0.57)	0.67 (0.48-0.94)	3.11 (2.65-3.65)	6.66 (5.96-7.43)	11.44 (10.50-12.45)	17.20 (16.01-18.48)	23.26 (21.81-24.79)	29.37 (27.65-31.18)	37.17 (35.05-39.38)	44.51 (41.92-47.19)	*50.31 (46.97-53.76)*

Table 3.S20 (page 302), Figure 3.S10 and Figure 3.S11 (pages 300 and 301) describe the mortality of patients receiving a primary shoulder replacement up to nine years following the primary procedure by gender and age group of the patients undergoing surgery for elective indications only. Data is shown at 30 and 90 days following the index procedure in Table 3.S20 and then every year until the ninth year. Mortality differences between the genders are small and while males have higher mortality within the first five years following surgery, mortality in the longer term appears more comparable, see Figure 3.S10. When mortality is further divided by age (Figure 3.S11), it is clear that older males have higher mortality than females, this pattern first becomes evident after the age of 65.

3.6.5 Conclusions

In this year's report, we provide extensive insight into the use and performance of shoulder constructs used in primary shoulder replacements and also give a detailed description of revision rates by the indication for surgery. A detailed description of the longitudinal PROMs data collection is also provided for both elective and trauma patients.

The pattern of use of primary shoulder replacements has continued to be documented. This year, we have continued to extensively revise shoulder implant data processing and, building on the recent internal and external validation, it is now possible to report at the level of the construct. This detailed level of reporting has led to new and interesting insights, but it has also highlighted some inconsistencies within data recorded in the registry, such as the 'unconfirmed' procedures that are now reported. These are procedures where the reported patient procedure disagrees with the implanted prostheses or there are insufficient elements recorded to verify a coherent joint replacement construct. The volume of unconfirmed proximal humeral hemiarthroplasty is consistently low, and the volume of unconfirmed conventional total shoulder replacements has fallen since the start of the registry. However, the volume of unconfirmed reverse polarity total shoulder replacements is consistently high and has increased further in recent years. The volume of unconfirmed reverse polarity total shoulder replacements is of concern as this now represents a significant proportion of all primary replacements. The lack of completeness hampers one of the core functions of the registry, which is to provide a comprehensive record of all implanted prostheses.

There are now 56,312 shoulder replacements eligible for analysis, after the application of our data cleaning processes. Patterns of use and the completeness of data are becoming clearer and revision rates out to nine years can be analysed. PROMs data continue to be collected so that patient outcomes in terms of pain and function can also be assessed alongside revision rates. It has previously been identified that some patients who have worse post-operative PROMs scores, i.e. a poor outcome, are not captured by the metric of revision surgery.

Confirmed reverse polarity total shoulder replacement made up 57.7% of all shoulder replacements in 2021 and the patterns of use observed in previous reports continue. This high level of use across indications indicates a growing confidence in this implant and a rapid change of practice in the registry's operational geographical areas, despite limited high-level outcome evidence. Proximal humeral hemiarthroplasties, and to some extent conventional total shoulder replacements, are declining in numbers.

Revision rates this year do not alter the pattern observed last year. Revision rates in patients under the age of 55 continue to be high and are now 10.9% and 9.8% in males and females respectively at five years, increasing further to 14.3% and 11.4% in males and females respectively at seven years. These revision figures are high compared to older age groups and should be addressed in clinical discussions with younger patients wishing to undergo shoulder replacement surgery.

At present, reverse polarity total shoulder replacement demonstrates the lowest revision rates at nine years. However, it is worth highlighting that these procedures have a higher early revision rate compared to stemmed conventional total shoulder replacements, until approximately three years following surgery.

After three years the revision rate of stemmed reverse polarity shoulder replacements falls below stemmed conventional total shoulder replacements. The observed non-proportionality between conventional and reverse bearings combined with the differing indications between the two procedures does not necessarily mean that reverse polarity shoulder replacements should be favoured over conventional total shoulder replacement, particularly for indications that would normally indicate the latter.

More elective proximal humeral hemiarthroplasties are being revised after the first year of surgery, with stemmed hemiarthroplasty seeming to outperform either resurfacing or stemless hemiarthroplasty. While it may be argued that the higher revision rate is mediated by the ease of the revision procedure, the PROMs data evidenced in this report does not support this. The change in PROMs score between the pre-operative and 6-month assessment following surgery suggests less improvement and that the group of patients that receive a humeral hemiarthroplasty report less positive outcome measures with the primary operation compared to others.

We suggest that more in-depth analysis which accounts for case-mix should be conducted as, while the age and gender distribution is similar, the distribution of indications for which patients undergo proximal humeral hemiarthroplasty is different to that of either conventional total shoulder replacement or reverse polarity shoulder replacement, with a much higher proportion of patients indicating avascular necrosis. An in-depth analysis accounting for the variety of indications collected by the registry and other clinically relevant factors may help surgeons select different treatment modalities for patients.

This year we have presented a detailed description of PROMs data with reference to not only those who have responded, but the entire cohort of patients receiving a primary shoulder replacement. The pre-operative scores are administered and collected by hospital trusts and our analysis demonstrates that hospital trust compliance is poor against the defined criteria. Better collection strategies need to be developed nationally to improve this low compliance. The post-operative PROMs are administered directly to patients on the NJR's behalf by their authorised contractor, NEC Software Solutions and consideration of how many people respond and the timing of when they respond is now also being addressed. The completeness of measures cross-sectionally and importantly from a longitudinal perspective and how this has changed across the years has been described. A pre-operative and 6-month matched elective cohort of 4,112 patients is now available for analysis, but the representative nature of this data compared to the whole cohort is not clear. It illustrates, in those who completed the PROMs, that shoulder replacement surgery results in substantial improvement in both pain and function for patients. However, it is less clear how those who do not complete the PROMs fare, and the revision rate of those who do not respond to the PROMs questionnaires does appear to be different and higher, when it is compared to those who do respond.

The largest gains by elective patients can be observed in those patients receiving a conventional total shoulder replacement, followed closely by those receiving a reverse polarity shoulder replacement, which is thereafter followed by those receiving a proximal humeral hemiarthroplasty.

Overall, in this section of the report we have shown that the volume of shoulder replacement surgery in the registry continues to grow, although the COVID pandemic has had a clear impact on provision of such surgery. The increasing dataset now presents an opportunity for outcomes to be assessed both by revision rates and by PROMs, although careful consideration of the latter in respect to its generalisability is required. Importantly, our new approach of whole construct validation using new classifications and component attributes will lead to more meaningful analysis and thus the provision of more robust information for patients, surgeons and other interested stakeholders.

3.7 NJR Supported Research

NJR Supported Research

The NJR strongly encourages use of the registry dataset to answer research questions that add value to our knowledge about joint replacement practice, clinical performance, cost-effectiveness and patient safety. Over the last 12 months, 22 research papers have been published using NJR data, covering a broad range of topics across the shoulder, hip, knee and ankle joints. Researchers effectively use the data to analyse questions about outcomes in relation to particular underlying disease and patient comorbidity, as well as address clinical and cost-effectiveness outcomes related to the implant prosthesis used.

In the following section, we provide brief summaries for four papers that were published during the Annual Report timeline. These papers illustrate the opportunities for external researchers to access the NJR dataset to ask questions not only about joint replacement outcomes, but also to test and validate novel analysis methodologies. Each of them demonstrates the value of the use of this collected data to the orthopaedic community to ultimately improve patient outcomes.

Further details of these and other research publications using NJR data can be found in Appendix 4 at **reports.njrcentre.org.uk/downloads**.

3.7.1 Temporal trends of primary hinge knee arthroplasty and risk factors associated with revision: National Joint Registry data from 2003 to 2018 for 4921 patients

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The Knee 2022; 34: 279-87
https://doi.org/10.1016/j.knee.2022.01.004

Background

Hinged knee arthroplasty[1] (HKA) is infrequently used in UK practice as a primary implant and is generally employed in the salvage setting. As such, HKA represents a highly constrained device and often an implant of choice for end-stage disease where there is a combination of bone deficiency around the knee and an inadequate soft tissue envelope. Early designs were met with poor outcomes from early loosening with an increased risk of revision.

Single centre units, often with small numbers, report promising early survival rates, but there remains limited information for medium-term outcome.

This analysis of National Joint Registry (NJR) data strove to examine the demographics behind primary hinge usage in a national contemporary practice to determine risk factors for failure as defined by recorded subsequent revision. For such a specific sub-set of cases, national registry data could offer the opportunity to review large numbers of cases over sequential years and offer meaningful interpretation.

The primary aim of this study was to describe the temporal changes of the utilisation of HKA in the UK and the associated changes in patient demographics and surgical variables.

Methods

Data access

From April 2011 completion of a NJR primary knee arthroplasty minimum dataset record form K1 form has been mandatory for all publicly financed primary knee replacements performed in England and Wales. For this work, data was extracted for 4,921 patient episodes between 08/04/2003 and 21/12/2018.

Dataset

The dataset contained all information reported on the K1 form at the time of surgery. This included patient demographic data (age, gender, body mass index (BMI), ASA grade), operative data (surgeons and operating unit code, year of surgery, lead surgeon grade, indication for surgery, surgical approach) and implant data (brand of hinged implant, component details). All implant constructs within the dataset were reviewed and classified into two groups depending on the degree of rotational freedom within the hinge mechanism. Details of subsequent revisions undertaken before the censor date (02/08/2019) allowed for classification into 'unrevised' or 'revised' at the time of censoring.

Statistical analysis

Categorical variables were analysed using chi squared tests and continuous variables were analysed using Wilcoxon rank sum tests[2], as the distributions of the variables were asymmetric. Unadjusted Kaplan-Meier plots were used to display time to revision and calculate the percentage of unrevised HKA (revision rate was calculated as one minus the unrevised rate). Cox proportional hazards was used to assess which explanatory variables affected time to revision. All the analysis was in R version 3.5.3.

Results

Patient demographics, indications, and surgical variables

Overall, there were 4,921 patient episodes analysed with a median age of 75 (interquartile range 65 to 82) at time of surgery, of which the majority were female (72.9%). The majority (54.3%) of patients were ASA grade II and the predominant indication for a HKA was osteoarthritis (73.0%). The majority of procedures were performed by a consultant surgeon (91.2%).

Temporal changes during study period

There were only 35 HKA recorded in 2003, followed by a year-on-year increase that peaked at 509 implantations in 2017. There was a relative decrease in HKA use in male patients (p=0.010), from approximately 30% at the beginning to 25% by the end of the study period.

The proportion of patients having surgery for the indication of 'osteoarthritis' (p<0.0001) or 'inflammatory arthritis' (p=0.005) both declined between 2003 and 2018, whereas the proportions performed for 'previous trauma' (p<0.0001) and 'other indications' (p<0.0001) increased (Figure 3.1). Fixed hinges knee arthroplasty reduced relatively from 51% to 25% between 2003 and 2018 with an increase in the use of rotating hinge systems from 46% to 69% (p<0.001) (Figure 3.2, page 309).

Figure 3.1 Proportion of cases selected for each indication for surgery 2003-2018.

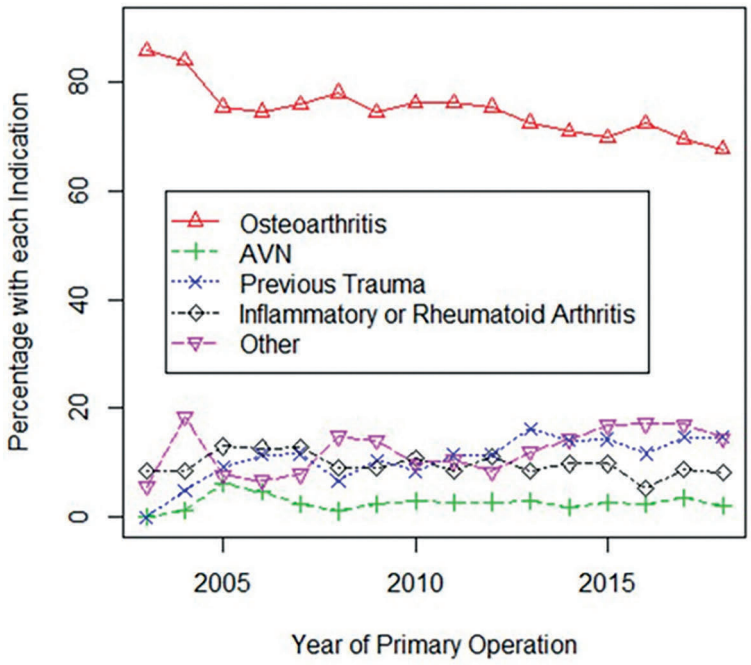
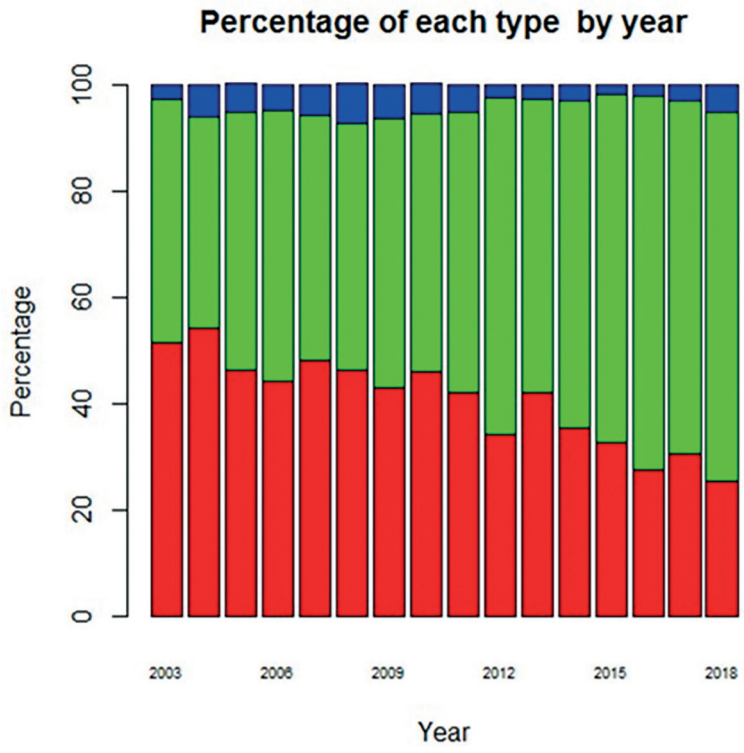


Figure 3.2 Use of fixed versus rotating hinged knee implants (2003-2018).
(Red=fixed, green=rotating, blue is unknown)



Revision

The median follow-up for the study cohort (n=4,921) was 5.5 years (range 0 to 16.3 years). During the study period there were 227 revisions performed at a median follow-up of 695 (range 1 to 4,376) days. The overall unadjusted probability of revision for all HKA at 1, 5 and 10 years after surgery was 1.5% (95% Confidence Interval (CI) 1.1-1.8), 4.4% (95% CI 3.7-5.0) and 6.4% (95%CI 5.5-7.3), respectively. Cox proportional hazard analysis demonstrated younger age, male gender, morbid obesity (BMI>40kg/m^2) or previous trauma were associated with an increased risk of revision. The additive effect of younger age and male gender resulted in a 10-year probability of revision of more than 10% for males less than 64 years of age (Figure 3.3, page 310), whereas a probability of revision of more than 10% at 10 years was only observed in females less than 55 years old (Figure 3.4, page 310).

Figure 3.3 Probability of male patients remaining unrevised dependent upon age group.

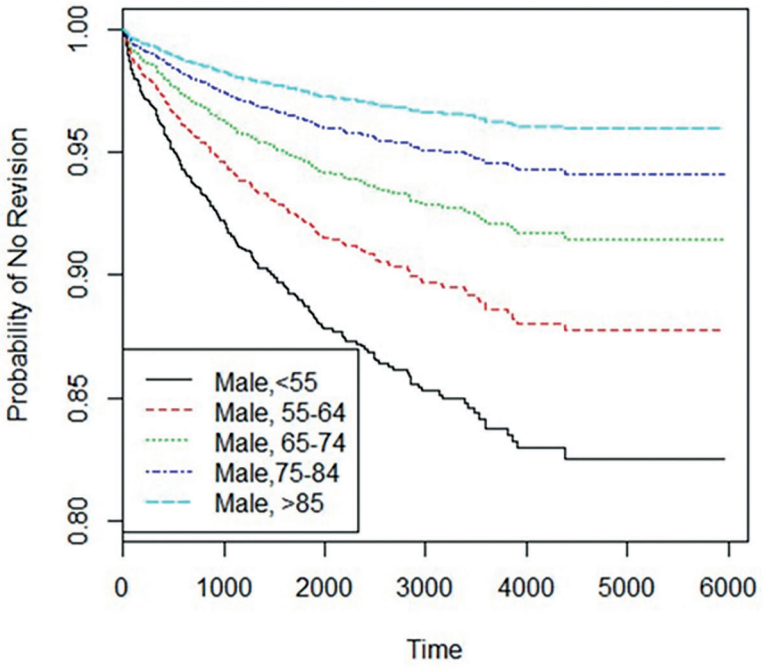
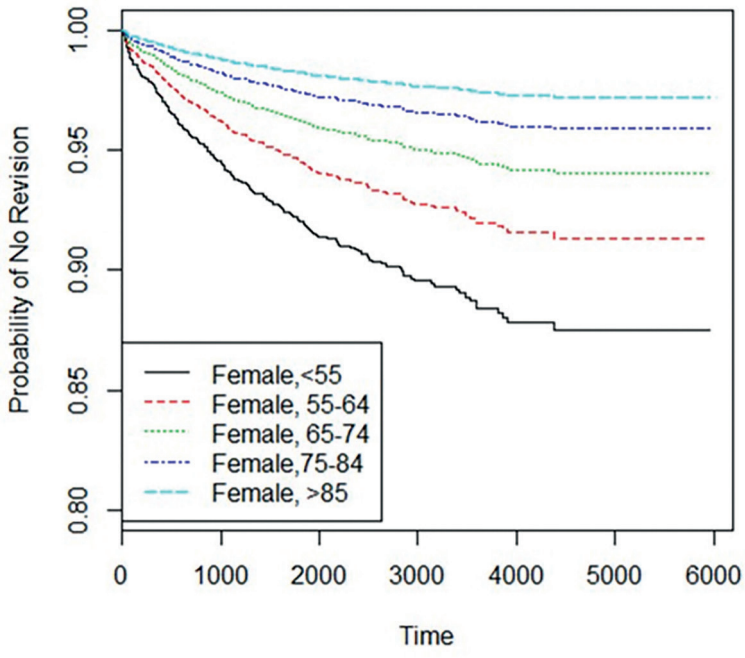


Figure 3.4 Probability of female patients remaining unrevised dependent upon age group.



Discussion

This study found an increase in the use of HKA as a primary implant from the NJR dataset over the 16 year period examined, with an overall unadjusted 10-year probability of revision following HKA of 6.4%. A key indication for HKA use in the primary setting is the unstable valgus knee with incompetence of the medial ligament constraint, and poor bone quality in an elderly female.

The incidence of 'trauma' associated indications was found to have increased over the period of observation. Primary hinge implantation for peri-articular knee fracture is akin to hemiarthroplasty in the hip with a similar early mortality risk.

The use of a primary HKA has classically represented a small percentage of overall use in UK and European practice. Concerns around increased constraint and early failure have limited the application of HKA as a primary implant. The rate of reported revision after HKA ranges from 7.5% to 49% at 10 years which is likely related to the mixture of surgical indications and the heterogenous primary or revision cases in previous cohorts.

Data from the Norwegian registry for 197 primary HKA procedures demonstrated a 5-year revision rate of 14%, double that observed in the current study of 6.4%. Such a difference may be due to the lower median age (5 years) and greater proportion of those requiring a primary HKA following trauma (14%) in their cohort as these two factors were demonstrated to be associated with increased risk of revision in the current study.

Male gender and morbid obesity were shown to be associated with an increased risk of revision, a finding supported from analysis of the primary unconstrained TKA NJR dataset cohort. Overall, 6.4% of patients undergoing primary HKA were revised at 10 years. Younger age (males under 65 and females under 55 years old), male gender, morbid obesity or previous trauma as the indication were associated with an increased risk of revision. The treating surgical team may wish to therefore consider an alternative implant design, but certainly could counsel the patient as to their risk of revision prior to surgery given these established risk factors.

[1]Hinged Knee Arthroplasty (HKA): Knee replacement where the femoral and tibial components are mechanically linked, offering the highest level of constraint.
[2]Wilcoxon Rank-Sum Test: Statistical method to test the null hypothesis that two populations will have no significant differences or variables. Data are randomly paired and measured on an interval scale.

3.7.2 Floor and Ceiling effects in the Oxford Shoulder Score: An analysis from the National Joint Registry

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Bone Joint J 2021;103-B(11):1717–1724 **https://doi.org/10.1302/0301-620X.103B11.BJJ-2021-0668.R1**

Background

The Oxford Shoulder Score (OSS) is a validated patient-based questionnaire used to assess shoulder pain and function. Previous studies have highlighted that post-operative ceiling effects are an area of concern for many commonly used orthopaedic patient reported outcome measures (PROMs). Floor and ceiling effects are psychometric properties useful in examining bias at the extreme ends of an outcome score. In the orthopaedic literature, if more than 15% of respondents achieve either the highest or lowest possible score, these effects are present.

The aim of this study was to assess whether floor and ceiling effects are present in the OSS in patients undergoing shoulder arthroplasty. Secondary aims were to identify if these effects were also present in the pain and function sub-scales of the OSS and whether these are affected by age, gender, hand dominance, indication for surgery and type of arthroplasty performed. We also aimed to identify pre-operative independent predictors for patients that will go on to achieve the best possible or ceiling score post-surgery.

Methods

For this study we used the NJR shoulder arthroplasty dataset, which contained a total of 46,824 shoulder observations with 16,238 pre-operative; 22,689 6-month; 3,244 3-year and 4,653 5-year post-operative OSS questionnaires. All statistical analyses were performed using STATA Version 16. Mean, median and standard deviation of the OSS at each time point was calculated as well as the percentage of patients achieving each possible score (0-48). We used the 15% threshold for calculating floor and ceiling effects, and further analysed according to age groups (≤39, 40-49, 50-59, 60-69, 70-79, 80-89, ≥90), gender, hand dominance, indication (trauma or arthritis), type of arthroplasty performed (hemiarthroplasty, resurfacing, reverse polarity or anatomic total shoulder arthroplasty). Logistic regression analysis[1] was performed to identify independent predictors of scoring the highest possible score (ceiling effect) at five years by gender, age, dominant arm surgery, procedure type and pre-operative OSS.

Results

The mean pre-operative OSS score was 16.7 (SD 8.6), which increased to 34.5 (SD 11.2) and was maintained at three years with an OSS of 36.3 (SD 11.2) and 35.6 (SD 11.7) at five years. (Table 3.1, page 313)

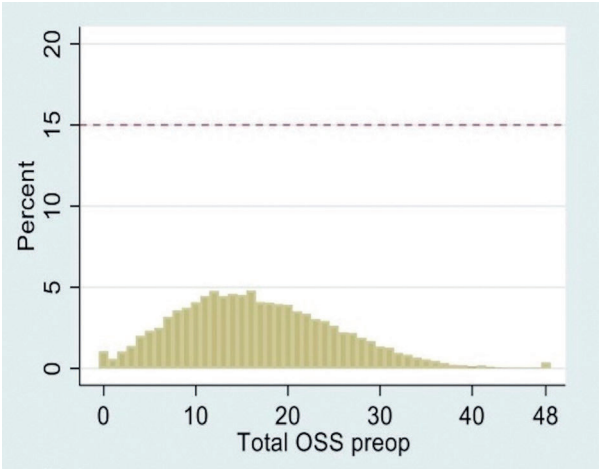
Table 3.1 The mean, standard deviation, median and the percentage (number) of patients scoring the worst and best scores of the Total OSS, for each time point – overall, by gender, for non-responders* and for linked responses**.

Time-point	n	Mean	SD	% Worst score 0 (n)	% Best score 48 (n)	% Best scores 44-48 (n)
Overall						
Pre-op	16,238	16.7	8.6	1.0 (169)	0.4 (58)	0.5 (82)
6 months	22,689	34.5	11.2	0.1 (20)	8.3 (1,894)	24.8 (5,623)
3 years	3,244	36.3	11.2	0.0 (0)	16.9 (548)	35.1 (1,139)
5 years	4,653	35.6	11.7	0.1 (3)	17.0 (789)	34.4 (1,600)
Male						
Pre-op	4,817	19.7	8.9	0.8 (40)	0.2 (12)	0.4 (20)
6 months	6,687	35.8	11.1	0.1 (6)	11.2 (748)	20.9 (2,063)
3 years	950	38	10.6	0.0 (0)	20.7 (197)	43.1 (409)
5 years	1,331	37.2	11.4	0.2 (2)	21.8 (290)	41.7 (555)
Female						
Pre-op	11,421	15.4	8.1	1.1 (129)	0.4 (46)	0.5 (62)
6 months	16,002	34	11.1	0.1 (14)	7.2 (1,146)	22.2 (3,560)
3 years	2,294	35.6	11.3	0.0 (0)	15.3 (351)	31.8 (730)
5 years	3,322	34.9	11.8	0.0 (1)	15.0 (499)	31.5 (1,045)
Non-responders*						
Pre-op	7,915	16.4	8.6	1.1 (88)	0.3 (25)	0.4 (33)
6 months						
3 years	81	32.2	12.9	0.0 (0)	12.3 (10)	24.7 (20)
5 years	122	34.9	12.3	0.0 (0)	16.1 (18)	33.9 (38)
Linked**						
Pre-op	2,084	17.8	8.3	0.6 (12)	0.3 (6)	0.5 (11)
6 months	2,084	35.3	10.7	0.1 (2)	8.3 (172)	26.2 (545)
5 years	2,084	36	11.6	0.1 (2)	17.6 (366)	36.9 (768)

*Non-responders = restricted to the patients who had a pre-operative OSS but not at six months.
**Linked = restricted to the 2,084 patients with total OSS recorded pre-operatively as well as at six months and five years.

No significant floor effects were noted at either of the time points or by sub-groups based on age, gender, indication or type of arthroplasty performed. Ceiling effects were noted for the overall OSS at three years (16.9%) and five years (17%), but not at six months post-operatively (see Figure 3.5). Although the threshold for a ceiling effect was not reached at six months a significant concentration of scores at the higher end of the spectrum were seen at this time point (see Figure 3.6, page 315).

Figure 3.5 Histograms showing the percentage of patients achieving each score of the Total Oxford Shoulder Score (OSS), including all patients recorded at the relevant timepoint.



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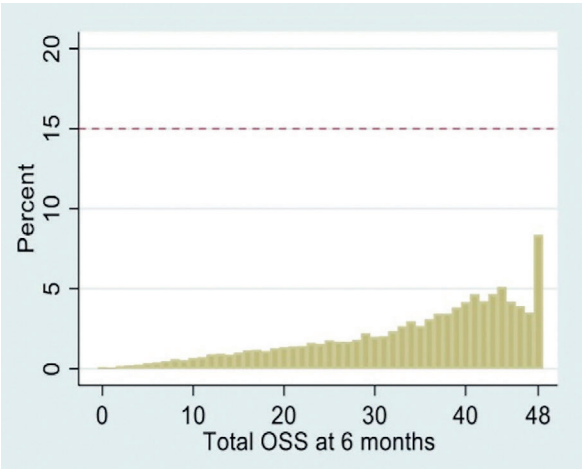

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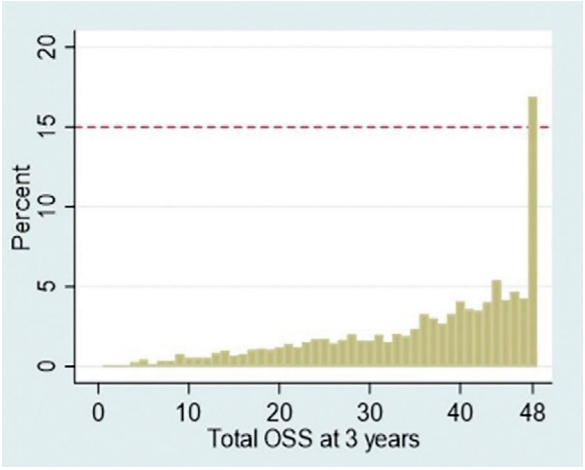

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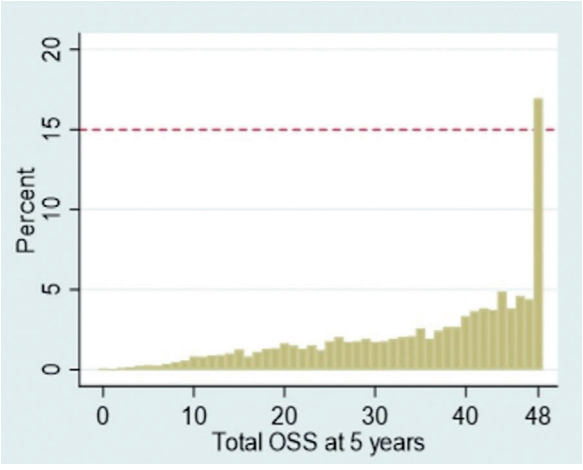
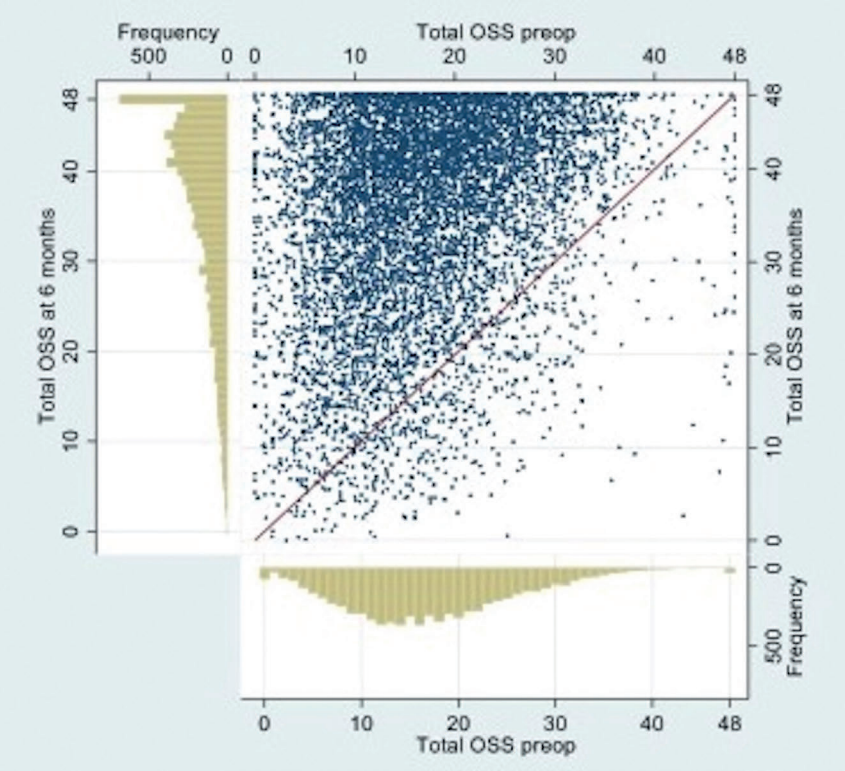


d

Figure 3.6 Plot of total Oxford Shoulder Score (OSS) score at six months versus pre-operatively, for the 7,523 patients with both recorded – with the marginal histogram included for both times.



Greater ceiling effects were noted in the male population compared to females at three years (20.7% versus 15.3%) and five years (21.8% versus 15.0%). Sub-analysis by age showed that a post-operative ceiling effect was most prevalent in the 60-69, 70-79 and 80-89 age groups at 3-year and 5-year time points. Dominant side surgery did not lead to a difference in post-operative ceiling effect when compared to non-dominant side surgery, whereas indication for arthroplasty did (17.7% for arthritis versus 11.5% for trauma at five years). Patients undergoing anatomical total shoulder arthroplasty[2] (ATSA) were more likely to score the maximum possible score versus other types of shoulder arthroplasties at all time points. A ceiling effect was not only present at three years (26.5%) and five years (25.5%), but also reaching close to the threshold at six months (13.6%). The OSS did not show a ceiling effect in the hemiarthroplasty, resurfacing arthroplasty, or reverse polarity total shoulder arthroplasty groups, suggesting that the ceiling effect seen in the overall OSS score for arthroplasty patients is largely driven by patients undergoing anatomic shoulder arthroplasty.

Post-operatively, 25.3% of patients achieved the highest possible score at three years and 26.3% at five years in the OSS pain component sub-scale[3] (OSS-PCS). Similarly, 25.2% of patients achieved the highest possible score at three years and 24.9% at five years in the OSS function component sub-scale[4] (OSS-FCS). Logistic regression analysis identified male gender, type of surgery, and pre-operative OSS to be independent predictors for scoring the highest possible score at five years post-operatively.

Discussion

Using the NJR shoulder arthroplasty PROMs dataset we have identified that the OSS demonstrates a ceiling effect at three years (16.9%) and five years (17%). Floor and ceiling effects were not seen at the pre-operative or 6-month time points when using the 15% cut-off. The OSS showed a ceiling effect in those patients aged between 60 and 89 years at 3-year and 5-year time points. When the analysis was performed based on the type of arthroplasty, patients receiving anatomic prostheses were more likely to score the highest possible score (26.5% at three years and 25.5% at five years) making the OSS disproportionately susceptible to ceiling effects post-operatively in this patient group. Sub-scale analysis demonstrated that the OSS-FCS and the OSS-PCS sub-scales were significantly more susceptible to ceiling effects than the complete questionnaire at almost all time points.

Recent orthopaedic literature has suggested that ceiling effects of clinical outcome scores should be considered when reviewing results of comparative studies.

If the outcome scores being used are affected by a significant ceiling effect, then it may be that the true outcome of each intervention cannot be accurately measured. This could lead to a higher risk of the null hypothesis being accepted in a study where a difference may exist, but the outcome score is unable to differentiate between relatively high performing patients. In our study this would be male patients aged between 60 and 89 years and those having an anatomic total shoulder arthroplasty.

Assessment of independent predictors for scoring a ceiling score in the OSS post-operatively has not been performed previously and may help identify patients that are likely to achieve the highest possible score. This may be important when designing comparative studies in a group of patients that are likely to perform well and therefore may benefit from an analysis of additional outcome measures that can help differentiate between treatment groups.

This study highlights the importance of investigating further the potential impact of ceiling effects on outcomes reported in comparative studies for interventions that lead to good but dissimilar outcomes.

[1]Logistic regression analysis: Mathematical model used in statistics to estimate the probability of an event occurring.
[2]Anatomical total shoulder arthroplasty (ATSA): Conventional shoulder replacement where the ball at the top of the upper arm bone is replaced by a metal ball and a new socket is inserted into the shoulder blade.
[3]OSS-PCS: OSS Pain component sub-scale. The pain section of Oxford Shoulder Score (OSS) which is a patient-reported questionnaire specifically developed for assessing outcomes of shoulder surgery.
[4]OSS-FCS: OSS Function component sub-scale. The function section of Oxford Shoulder Score (OSS) which is a patient-reported questionnaire specifically developed for assessing outcomes of shoulder surgery.

3.7.3 The effect of acetabular component geometry on the risk of revision for instability or loosening: a study on 427,385 primary hip arthroplasties from the National Joint Registry

Hiren M. Divecha, Terence W. O'Neill, Mark Lunt, Tim N. Board

This project was supported by The John Charnley Trust and the NIHR Manchester Biomedical Research Centre.

Bone Joint J 2021 103-B:11, 1669-1677. **https://doi.org/10.1302/0301-620X.103B11.BJJ-2021-0061.R1**

Bone Joint J 2021 103-B:12, 1774-1782. **https://doi.org/10.1302/0301-620X.103B12.BJJ-2021-0471.R1**

Background

Instability following total hip arthroplasty (THA) represents a common revision reason, although the absolute incidence is low. Within the NJR dataset 123,891 revision THA procedures have been recorded, of which 18,085 (15%) were for instability.

Acetabular bearing geometry plays a role in the range of motion before dislocation occurs. Cemented acetabular components are most commonly a long posterior wall[1] (LPW) design, with hooded[2] and offset reorientating[3] designs available. Uncemented acetabular polyethylene (PE) liners are available in neutral[4], offset neutral[5], lipped[6] and offset reorientating[7] designs. Asymmetric acetabular bearing surface designs can be implanted with the elevated rim in the position that most enhances THA stability. A downside to asymmetric acetabular bearing surface designs is the potential for impingement of the prosthetic femoral neck on the elevated rim, which could lead to subluxation or dislocation in the opposite direction. Repetitive impingement may transfer excess torque to the bone-implant interface and result in loosening of the acetabular component over time.

The aim of this project was to determine if acetabular component bearing geometry influences the risk of revision for instability or loosening, following primary THA with a cemented or uncemented acetabular component. The influence of time after primary THA and of uncemented PE lip size on revision risk for instability were also investigated.

Methods

Primary THAs were identified from the NJR dataset (2003-2017): 202,511 uncemented acetabular components implanted with PE liners and 224,874 cemented acetabular components, these groups were analysed separately. The effect of bearing geometry on the risk of revision for instability or for loosening was investigated using competing risk regression analyses adjusting for age, gender, ASA grade, indication, side, institution type, surgeon grade, surgical approach, head size and PE crosslinking. A time-split analysis was performed to investigate how revision risk for instability changes with time after primary THA. Stratified analyses by surgical approach were performed, including pairwise comparisons of liner geometries (with error rate control).

Results

Cemented cups

The LPW design was used most frequently, with decreasing use of the hooded design over the study period (Figure 3.7, page 318). There were 815 (0.36%) revisions for instability and 838 (0.37%) for loosening. Survival analyses are shown in Figure 3.8 (page 319). Compared to the LPW group, the adjusted subhazard ratio[8] (SHR) of revision for instability in the hooded group was 2.31 ($p<0.001$) and 4.12 ($p=0.047$) in the offset reorientating group (see Figure 3.8). The SHR of revision for loosening was 2.65 ($p<0.001$) in the hooded group and 13.61 ($p<0.001$) in the offset reorientating group. The time dependent SHR of revision for instability in hooded vs LPW cups (Figure 3.9, page 320) was greatest immediately post-operatively (4.8), falling over the first three months to 2.31 and then more gradually to 1.66 at one year. There was a further rise in the SHR to 2.4 at 2.5 years then it decreased up to four years, after which the broadening confidence interval limited further comparison.

Figure 3.7 Trend in cemented acetabular component use.

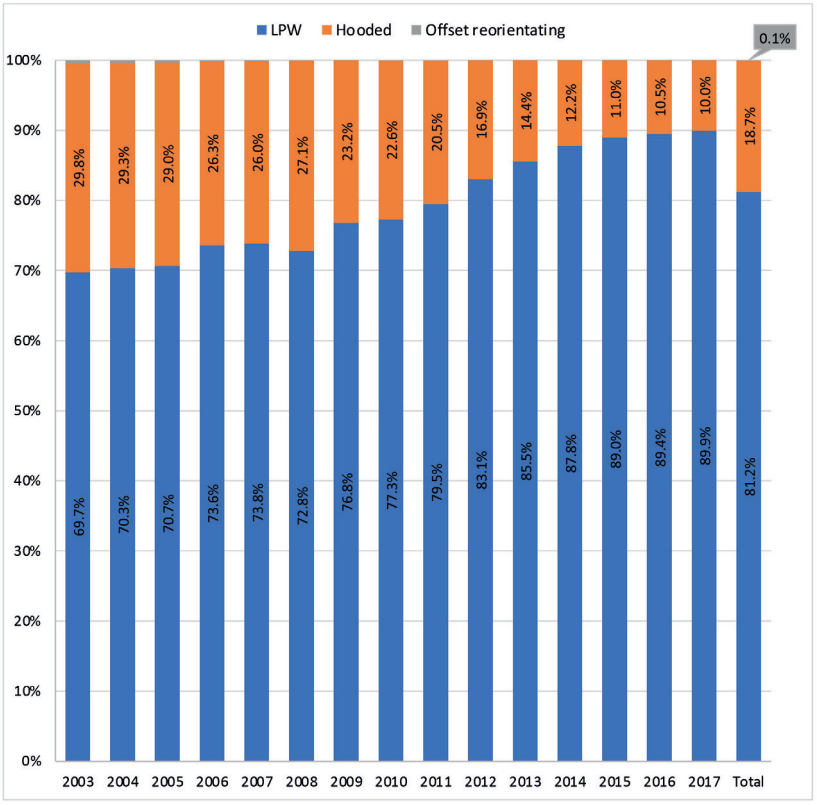
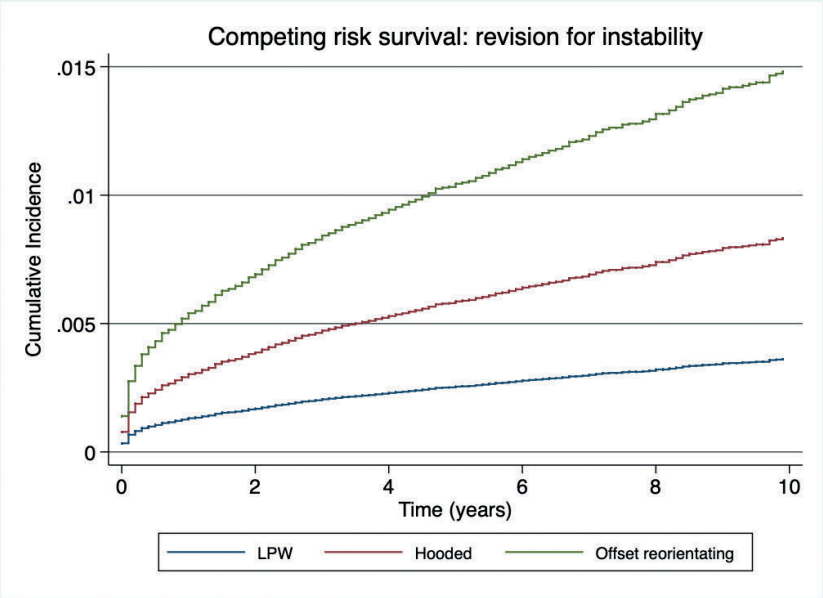


Figure 3.8 Cumulative incidence of revision for a) instability b) loosening by cemented acetabular component geometry. Adjusted competing risk analyses.



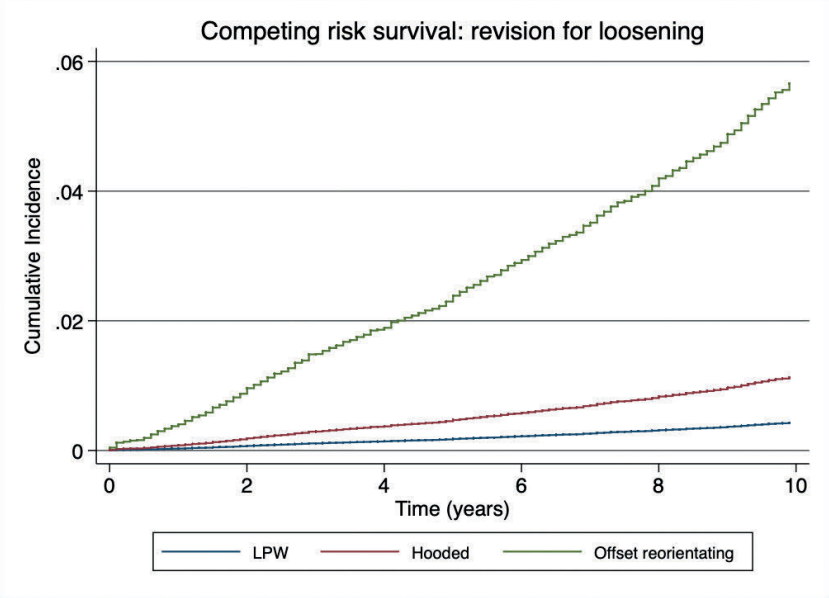
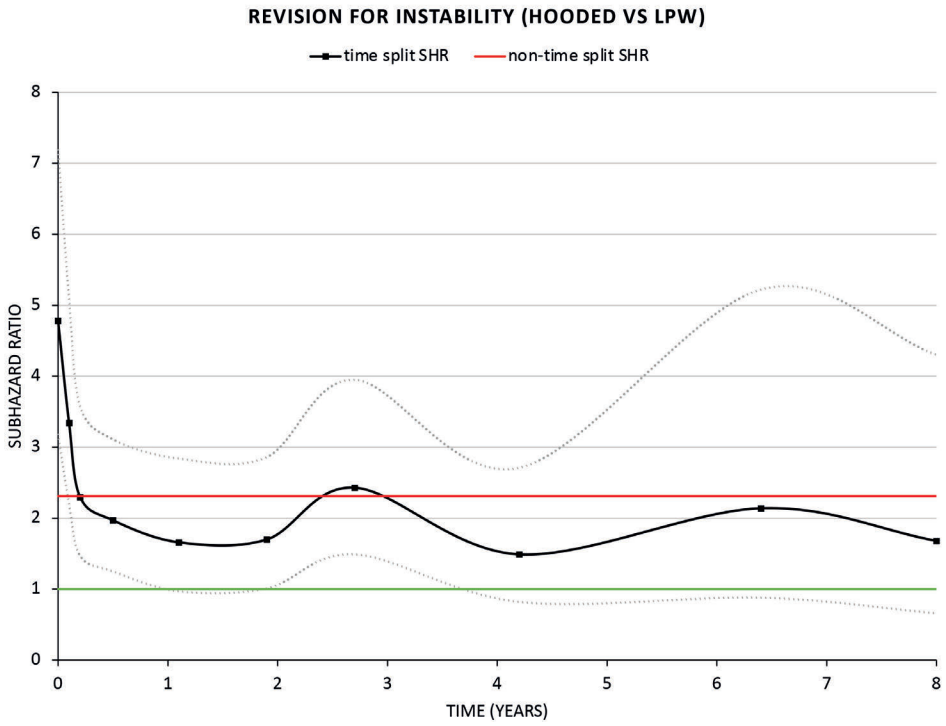


Figure 3.9 Subhazard ratio of revision for instability (hooded vs. LPW) by time from primary THA. A competing risk analysis.



In the analyses stratified by surgical approach (see Table 3.2, page 321), hooded cups remain at higher risk of revision for instability (compared to LPW cups) across all surgical approaches. Offset reorientating cups had a higher risk of revision for instability (compared to LPW and hooded cups) in 'other' approaches.

In revision for loosening stratified by surgical approach, hooded and offset reorientating cups remain at higher risk of revision (compared to LPW cups) across all surgical approaches. Additionally, in the posterior and lateral groups, offset reorientating cups were at higher risk of revision for loosening than hooded cups.

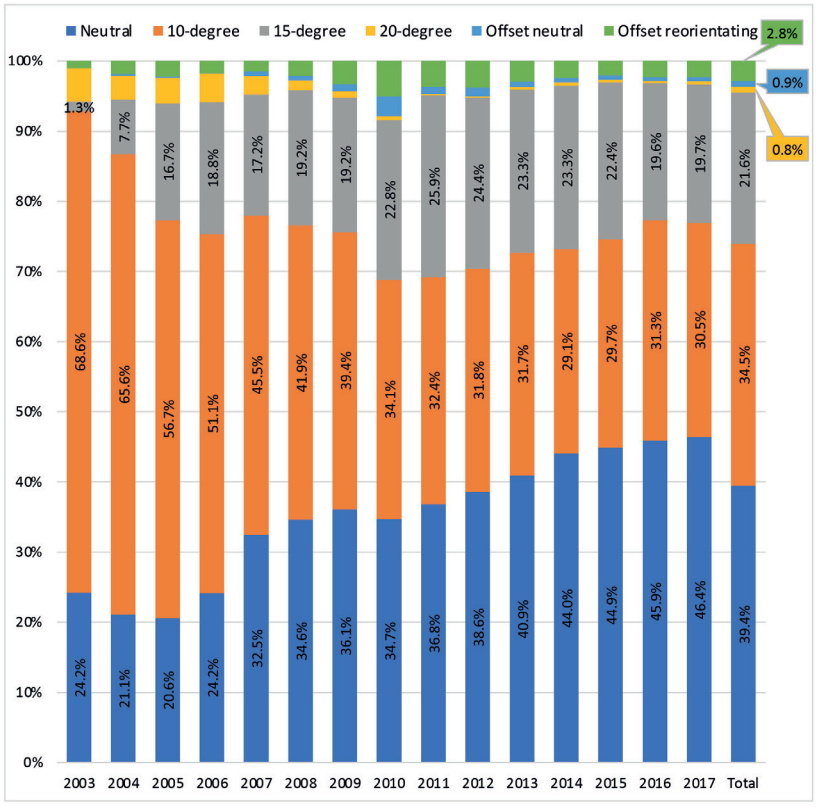
Table 3.2 Risk of revision for instability by acetabular component geometry, stratified by surgical approach – pairwise comparisons.

	Posterior approach (SHR) n=123,850 (55%)	Lateral approach (SHR) n=88,618 (39%)	Other approaches (SHR) n=12,406 (6%)
Revision for instability			
Hooded vs LPW	2.23 (1.76-2.81)	2.69 (1.81-3.98)	2.83 (1.02-7.82)
Offset reorientating vs LPW	too few	too few	31.68 (3.94-254.71)
Offset reorientating vs Hooded	too few	too few	11.2 (1.56-80.38)
Revision for loosening			
Hooded vs LPW	2.26 (1.7-3.01)	3.09 (2.33-4.09)	2.46 (1.28-4.71)
Offset reorientating vs LPW	15.47 (4.52-53.02)	13.72 (3.16-59.5)	8.31 (1.28-53.99)
Offset reorientating vs Hooded	6.84 (1.99-23.49)	4.44 (1.05-18.89)	3.38 (0.54-21.28)

Uncemented cups

A trend in increasing use of neutral and decreasing use of lipped liners was seen over the study period (Figure 3.10). There were 690 (0.34%) revisions for instability and 604 (0.3%) for loosening.

Figure 3.10 Trend in uncemented acetabular PE liner geometry use.



Survival analyses are shown in Figure 3.11. Compared to neutral liners, the adjusted SHR of revision for instability was 10-degree: 0.64 (p<0.001), 15-degree: 0.48 (p<0.001) and offset reorientating: 1.6 (p=0.01). No association between liner geometry and revision for loosening was found. Compared to neutral liners, the protective effect of 10- and 15-degree liners against revision for instability was greatest in the early post-operative period (Figure 3.12, page 323).

Figure 3.11 Cumulative incidence of revision for a) instability b) loosening by uncemented acetabular liner geometry. Adjusted competing risk analyses.

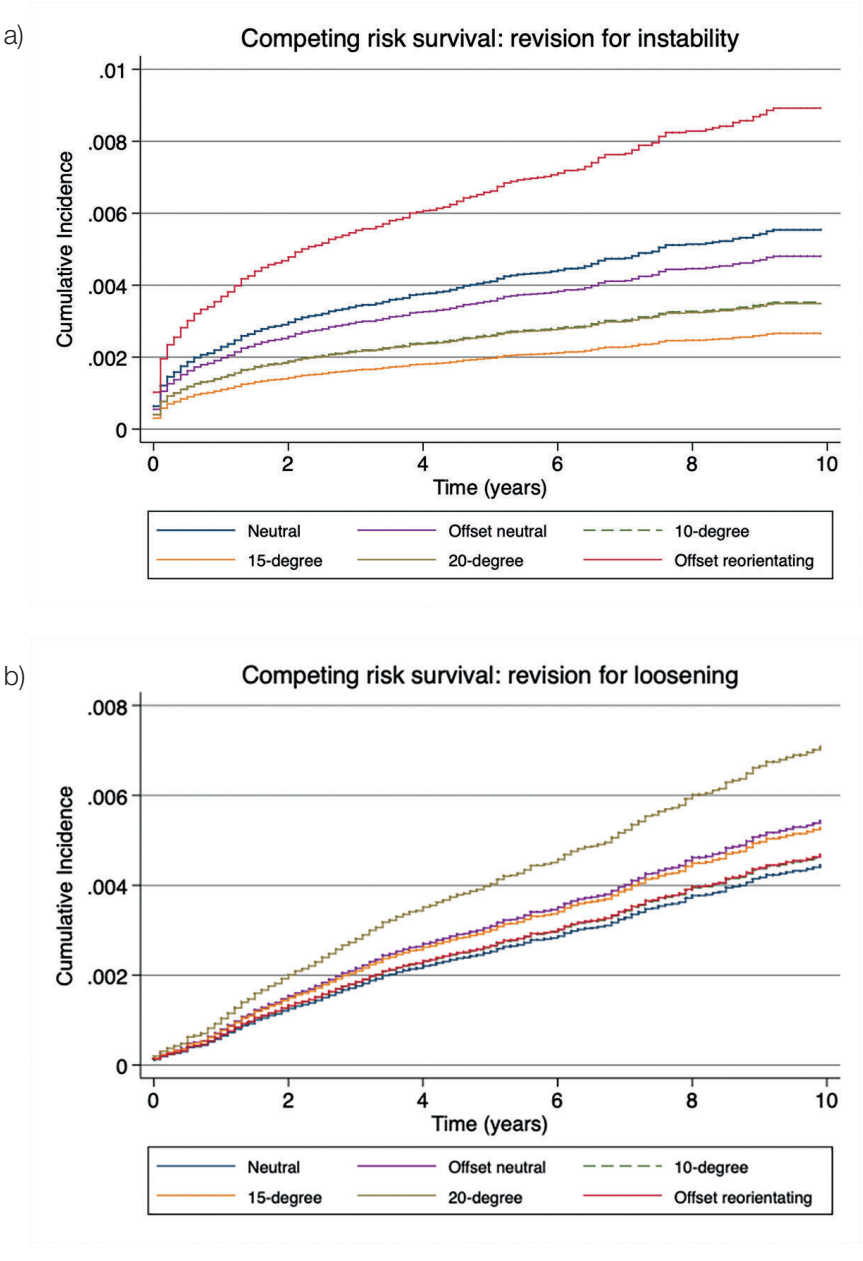
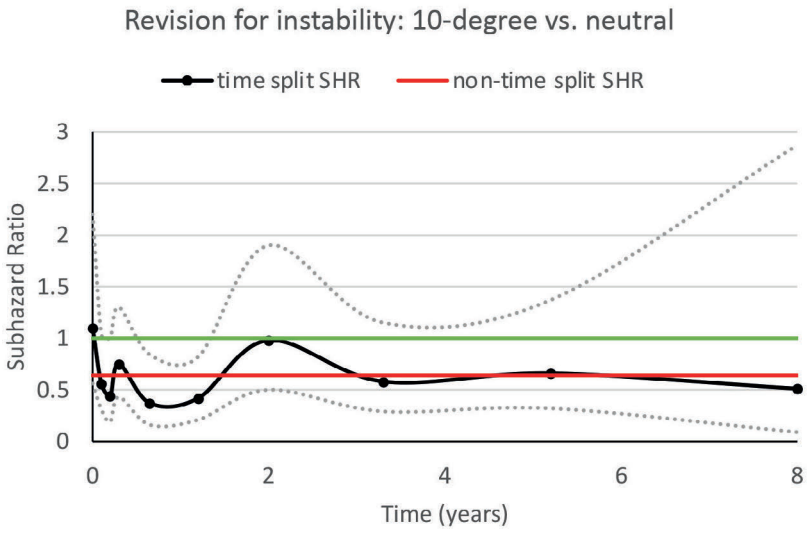
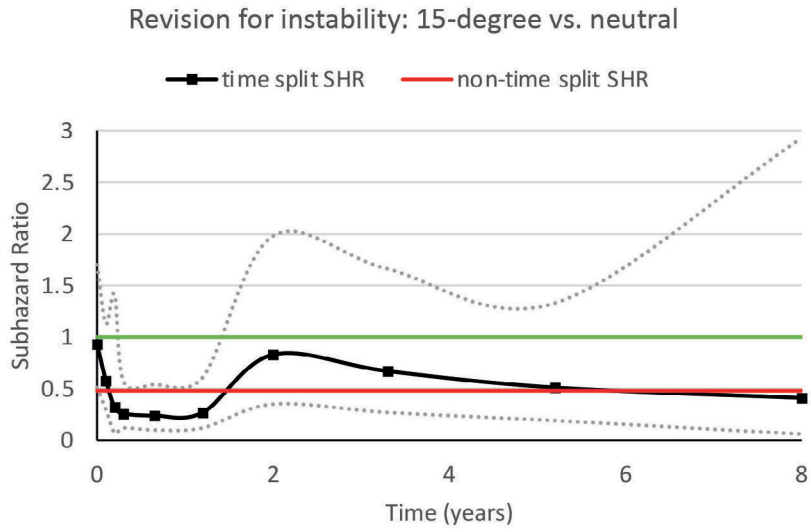


Figure 3.12 Subhazard ratio of revision for instability by time from primary THA a) 10-degree vs. neutral b) 15-degree vs neutral. Competing risk analyses.





Stratifying by surgical approach (see Table 3.3), in the posterior approach THAs, 10- and 15-degree liners had a lower risk of revision for instability compared to neutral liners. Offset reorientating liners had a higher risk of revision for instability than 10- and 15-degree liners in posterior THAs.

Table 3.3 Risk of revision for instability by uncemented acetabular liner geometry, stratified by surgical approach – pairwise comparisons.

Surgical approach	Posterior approach (SHR) n=138,470 (68.38%)	Lateral approach (SHR) n=55,542 (27.43%)
Offset neutral vs Neutral	0.53 (0.09 – 3.04)	3.56 (0.42 – 30.37)
10 degree vs Neutral	0.59 (0.39 – 0.88)	0.82 (0.44 – 1.53)
15 degree vs Neutral	0.36 (0.23 – 0.56)	0.89 (0.4 – 1.98)
20 degree vs Neutral	0.51 (0.13 – 1.97)	0.92 (0.05 – 18.04)
Offset reorientating vs Neutral	1.24 (0.68 – 2.25)	4 (1.09 – 14.68)
10 degree vs Offset neutral	1.11 (0.18 – 6.83)	0.23 (0.02 – 2.17)
15 degree vs Offset neutral	0.68 (0.12 – 4)	0.25 (0.03 – 2.15)
20 degree vs Offset neutral	0.95 (0.1 – 8.9)	0.26 (0.01 – 10.1)
Offset reorientating vs Offset neutral	2.33 (0.39 – 13.92)	1.13 (0.11 – 11.89)
15 degree vs 10 degree	0.62 (0.35 – 1.1)	1.09 (0.4 – 2.96)
20 degree vs 10 degree	0.86 (0.23 – 3.3)	1.13 (0.06 – 21.93)
Offset reorientating vs 10 degree	2.11 (1.01 – 4.41)	4.9 (1.14 – 21.02)
20 degree vs 15 degree	1.4 (0.34 – 5.83)	1.03 (0.05 – 22.58)
Offset reorientating vs 15 degree	3.42 (1.83 – 6.37)	4.49 (1.2 – 16.76)
Offset reorientating vs 20 degree	2.44 (0.55 – 10.84)	4.34 (0.17 – 110.67)

A summary of the competing risk analyses of revision risk by acetabular component geometry is provided in Table 3.4.

Table 3.4 Summary of adjusted competing risk analyses.

	Revision reason	
	Instability (SHR)	Loosening (SHR)
Cemented cups		
LPW (referent)	1	1
Hooded	2.31 (1.97-2.71)	2.65 (2.28-3.08)
Offset reorientating	4.12 (1.02-16.69)	13.61 (6.85-27.04)
Uncemented cups		
Neutral (referent)	1	1
Offset neutral	0.87 (0.35-2.14)	1.23 (0.56-2.68)
10-degree	0.64 (0.51-0.79)	1.05 (0.82-1.33)
15-degree	0.48 (0.37-0.62)	1.19 (0.89-1.6)
20-degree	0.63 (0.29-1.35)	1.6 (0.83-3.09)
Offset reorientating	1.61 (1.12-2.32)	1.05 (0.63-1.77)

Discussion

In this analysis of primary THA data from the NJR we have shown that in cemented acetabular components, hooded and offset reorientating components have a significantly higher risk of revision THA for instability and for loosening, compared to LPW components. Furthermore, the increased revision risk for instability with hooded components is most marked in the first three months following surgery, remaining elevated for the first year.

In primary THAs with uncemented acetabular components performed through a posterior approach, 10- and 15-degree lipped liners are associated with a lower risk of revision for instability compared to neutral liners, although no difference between the 10- and 15-degree liners was found. This protective effect was not found in lateral approach THAs. Offset reorientating liners have a higher risk of revision for instability compared to 10- and 15-degree liners regardless of the surgical approach used, an effect that is most pronounced in the early post-operative period. We found no association between liner geometry and the risk of revision for loosening.

The routine use of cemented hooded or offset reorientating cups, and of uncemented offset reorientating liners, should be avoided with their higher risk of revision for instability; but further study is required to determine if certain indications benefit from their use. Further studies are needed to examine the effects of lip position on revision for instability, if a true difference exists between 10- and 15-degree liners, and whether the benefits of lipped PE liners persist into longer term follow-up.

[1]Long posterior wall (LPW) cup: This cup design is flat on the bearing surface, with a vertical extension over part of the circumference that extends past the hemisphere. This confers some extra stability to dislocation of the femoral head.
[2]Hooded cup: Also known as a 'low profile' cup, this design has an elevated portion of the rim that extends the coverage of the femoral head in the area of the hood (more than the LPW cup).
[3]Offset reorientating cup: Also known as a 'high profile' cup, this design is similar to the hooded cup but has an increased PE thickness in the dome portion of the cup that lateralises the centre of rotation.
[4]Neutral liner: This liner design is flat on its bearing face and covers the femoral head by 180 degrees.
[5]Offset neutral liner: This liner design is flat on its bearing surface but the PE is thicker in the dome area of the liner than a neutral liner.
[6]Lipped liner: This liner design has an elevated rim that extends vertically past the hemisphere of the cup, the lipped portion covers half of the circumference of the bearing face and provides additional stability against dislocation.
[7]Offset reorientating liner: This liner design has an increased PE thickness in the dome portion of the liner, this lateralises the centre of rotation. The bearing surface covers 180 degrees of the femoral head but is reorientated from the hemispherical plane of the cup.
[8]Subhazard ratio (SHR): In competing risk analyses the subhazard ratio refers to the relative risk of failure from a specific cause between two exposure groups. Failures are retained in the risk set if the failure was due to an event other than the one of interest.

3.7.4 Metaparametric Neural Networks for Survival Analysis

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IEEE Transactions on Neural Networks and Learning Systems 2021 Oct 25; **https://doi.org/10.1109/tnnls.2021.3119510**

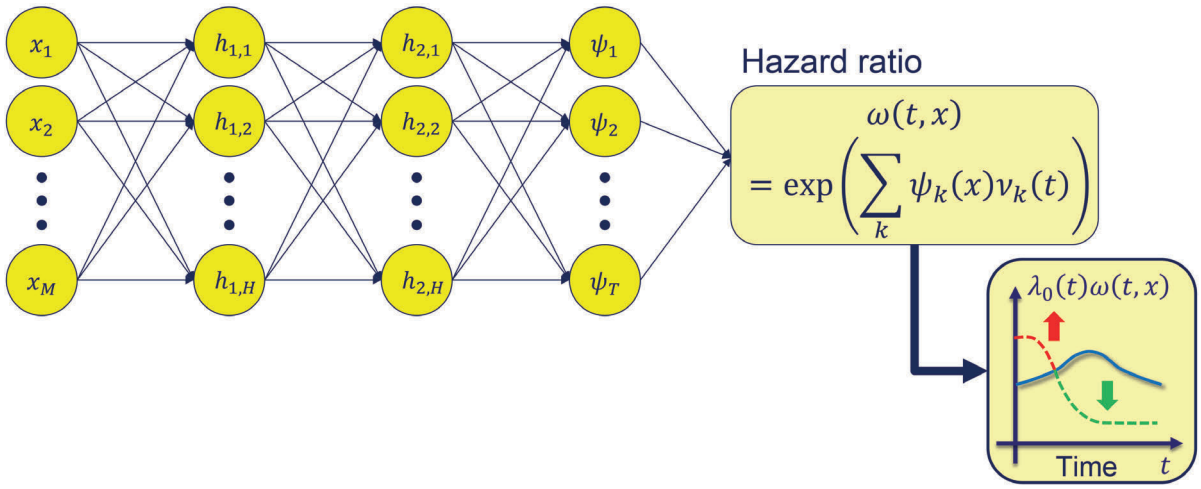
Background

Current survival analysis methodology, such as the Cox or flexible parametric models[1] generally work well for estimating survivorship in populations and its overall covariate dependencies. However, what happens if we want to accurately predict the survival of an individual within the population? Individual survival may vary significantly in complex patterns depending on the input characteristics. Similarly, the outcome may represent a compound end point populated by a complex set of reasons that are also highly variable and dependent on the input characteristics. In both Cox and flexible parametric models, the hazard ratio must be log-linear and time-constant and the baseline hazard ratio must be the same for all patients. It remains impossible to know if all the patterns captured by the model are true or if they are influenced by the model assumptions. In this paper, we describe the application of artificial intelligence to develop a novel method for individual survival outcome estimation, called the metaparametric neural network[2] (MNN), to solve the outlined problems associated with statistically-based methods.

Methods

In the MNN method the predictor variables for a given patient are inputted into a neural network to generate a coefficient for the hazard ratio that is non-linear and time-dependent, rather than representing an average function over time. The patient-specific coefficient is then fed into a proportional hazards model to generate a fully flexible event probability distribution that can take any shape and gradient (Figure 3.13, page 327). The MNN doesn't need data for every combination of variables to be able to estimate the model accurately, and the coefficient that is outputted from the network is unique to a given patient, resulting in a truly patient-specific survival model.

Figure 3.13 Outline of the Proportional Hazards Metaparametric Neural Network model. x=input variable, h=hidden variables with the neural network, ψ=coefficient for the hazard ratio for an individual patient.



Data from 612,914 hip replacements collected by the National Joint Registry (NJR) were used to validate the model. Marginalised hazard was computed as a function of age and BMI for different follow-up time points. Various formulations of the MNN model (DH-MNN, PH-MNN, QR-MNN) were compared against standard statistical (Cox) and other neural network survival models (DeepHit, DeepSurv) and their relative performance assessed.

Results

Figures 3.14 and 3.15 (page 329) represent marginalised cumulative hazard ratio analyses at different time points for revision as a function of age and BMI, respectively. Each model is compared against the Kaplan-Meier observed data. From these figures, it is clear that the probability distribution is both time-dependent and non-linear in respect of both age and BMI, and the model that best captured both of those aspects was the proportional hazards MNN (PH-MNN)[3].

Figure 3.14 Estimated cumulative hazard ratio for the risk of revision marginalised as a function of age.

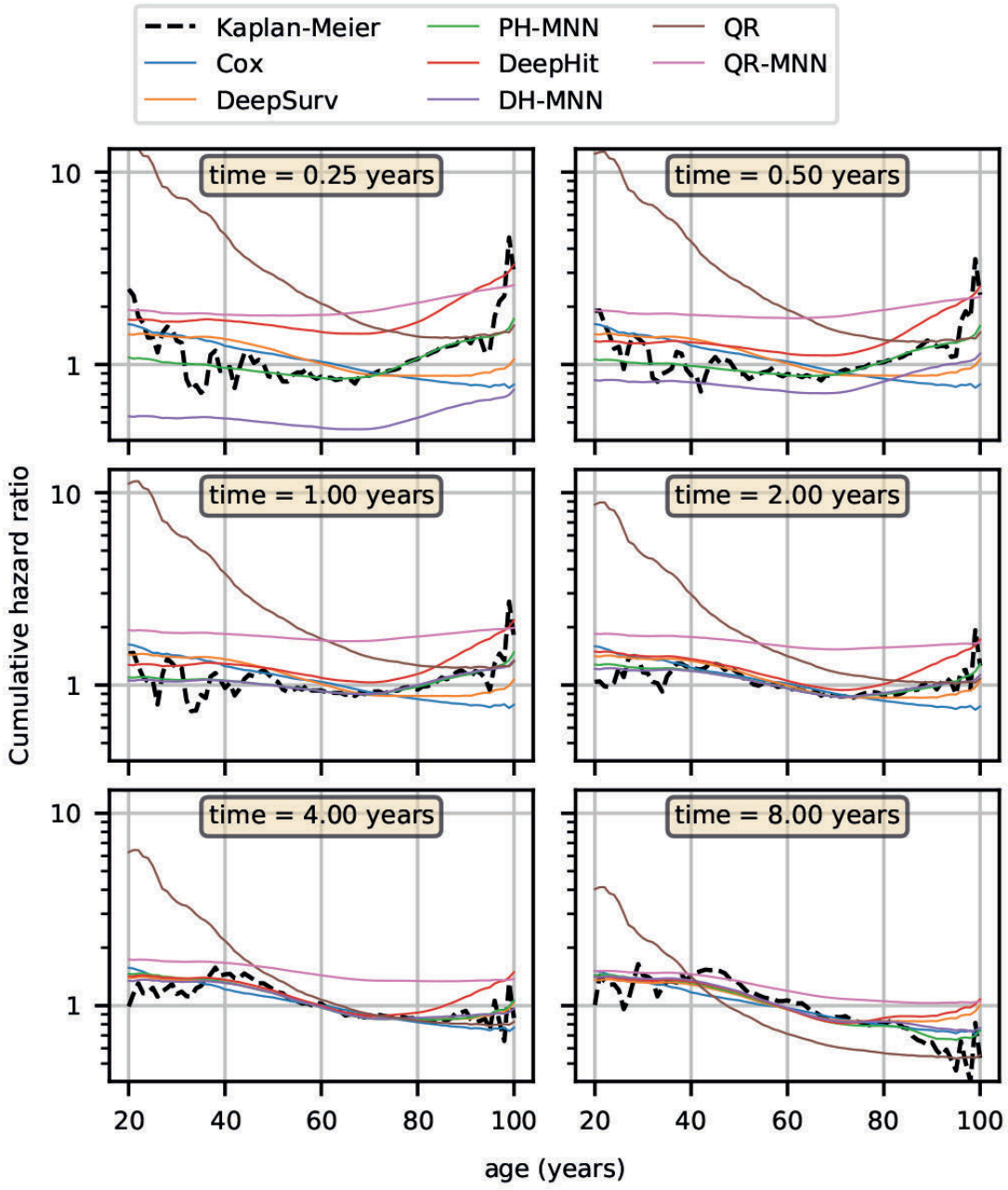


Figure 3.15 Estimated cumulative hazard ratio for the risk of revision marginalised as a function of BMI.

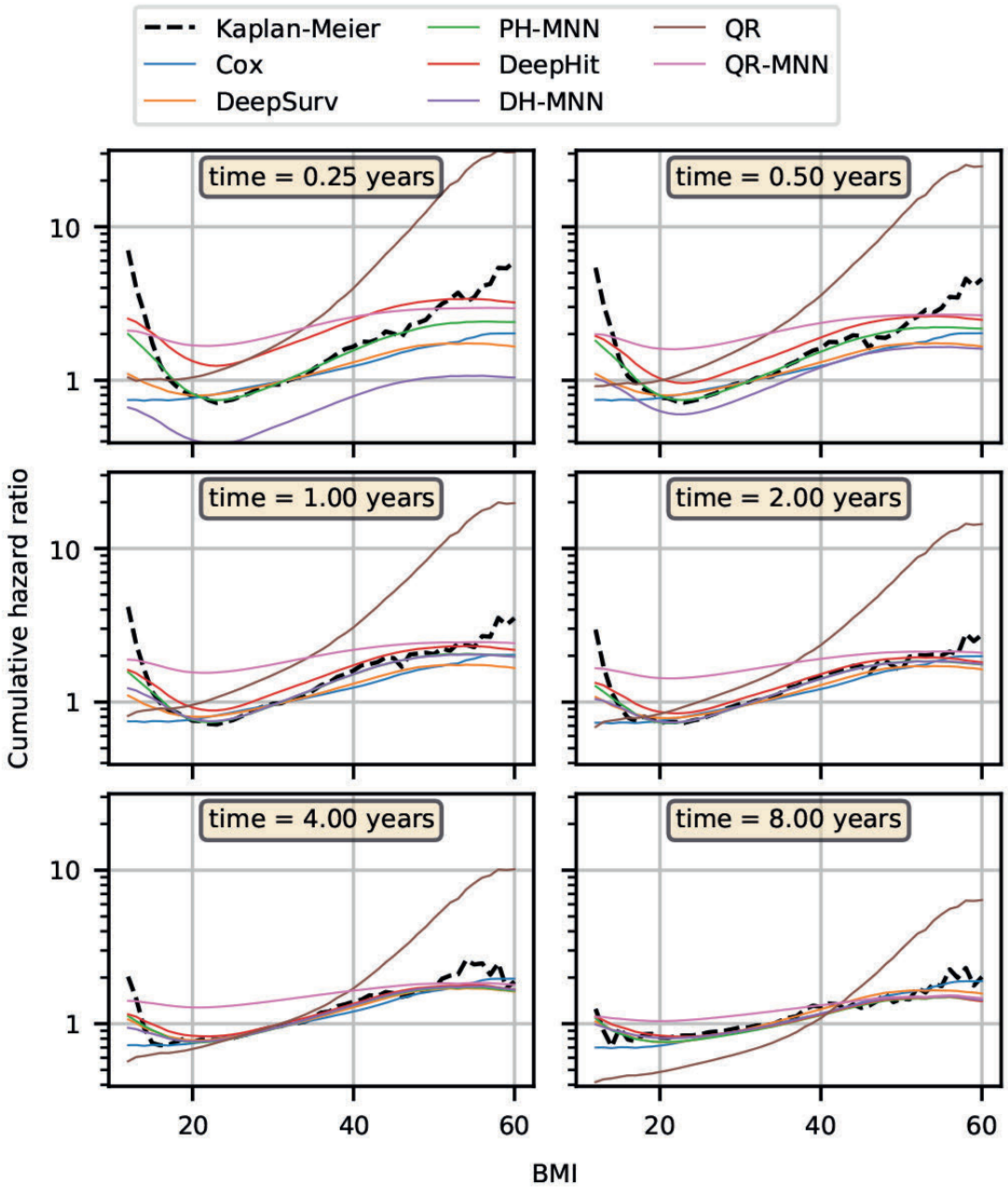


Table 3.5 shows the maximum root mean squared estimation error and bias for the marginalised cumulative hazard ratio for Cox, a conventional neural network and the PH-MNN models for estimating individual mortality and prosthesis revision risk marginalised for age and BMI.

Table 3.5 Maximum root mean squared error and bias over time for selected models when estimating individual risk of revision or mortality.

	Cox	DeepSurv	PH-MNN
Revision by age			
RMSE	0.225±0.002	0.213±0.002	0.154±0.003
URMSE	0.221±0.003	0.209±0.002	0.146±0.002
abs. bias	0.060±0.003	0.057±0.003	0.070±0.002
Mortality by age			
RMSE	0.567±0.002	0.313±0.004	0.189±0.004
URMSE	0.522±0.002	0.279±0.003	0.181±0.004
abs. bias	0.243±0.002	0.159±0.003	0.071±0.004
Revision by BMI			
RMSE	0.148±0.002	0.140±0.002	0.124±0.002
URMSE	0.140±0.001	0.130±0.002	0.107±0.002
abs. bias	0.074±0.003	0.068±0.003	0.081±0.002
Mortality by BMI			
RMSE	0.197±0.002	0.135±0.002	0.133±0.003
URMSE	0.193±0.001	0.127±0.002	0.121±0.003
abs. bias	0.053±0.003	0.052±0.003	0.061±0.003

Discussion

The MNN structure proposed here provides a framework that can be used to extend survival models for individual outcome estimation, achieving arbitrarily time-dependent and non-linear modelling. Among the models, the PH-MNN model achieved the best overall performance. The use of the PH-MNN model in healthcare applications allows the detection of time-dependencies and non-linearities without the need of explicitly including them in the model before estimation. This is a particularly important feature in problems where the underlying causes of event risks are not exhaustively known prior to the analysis, since the model can help detect non-linearities and time dependencies within the predictor variables without the need of explicitly searching for them.

[1]Flexible parametric model: A survival model that follows the proportional hazards assumption and is distinguished from the Cox model by using a natural cubic spline representation for the baseline hazard function.
[2]Metaparametric Neural Network (MNN): A framework that combines neural networks with basis functions to achieve a “grey-box” function representation.
[3]Proportional Hazards Metaparametric Neural Network (PH-MNN): A semi-parametric survival model that uses the MNN framework to provide a time-dependent and non-linear parametric representation of the hazard ratio, allowing it to approximate any continuous survival function.

Published papers 2021-2022

Details of published analyses that have been sanctioned by the NJR Research Committee between April 2021 and March 2022. NJR data are available for research purposes following approval by the NJR Research Committee. For further details please visit the NJR website at **www.njrcentre.org.uk**.

The effect of surgical approach in total knee replacement on outcomes. An analysis of 875,166 elective operations from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man. Blom AW, Hunt LP, Matharu GS, Kunutsor SK, Reed M, Whitehouse MR. Knee. 2021 Aug;31:144-157 doi: 10.1016/j.knee.2021.04.009

How long do revised and multiply revised knee replacements last? A retrospective observational study of the National Joint Registry. Deere K, Whitehouse MR, Kunutsor SK, Sayers A, Price AJ, Mason J, Blom AW. Lancet Rheumatol. 2021 Jun;3(6):e438-e446. doi: 10.1016/S2665-9913(21)00079-5

Trends in the utilization of ankle replacements: Data from worldwide national joint registries. Perry TA, Silman A, Culliford D, Gates L, Arden N, Bowen C. Foot Ankle Int. 2021 Oct;42(10):1319-1329 doi: 10.1177/10711007211012947

Obesity and revision surgery, mortality and patient reported outcomes after primary knee replacement surgery in the National Joint Registry: A UK cohort study. Evans JT, Mouchti S, Blom AW, Wilkinson JM, Whitehouse MR, Beswick A, Judge A. PLoS Med. 2021 Jul 16;18(7):e1003704. doi: 10.1371/journal.pmed.1003704

A comparison of comorbidity measures for predicting mortality after elective hip and knee replacement: A cohort study of data from the National Joint Registry in England and Wales. Penfold CM, Whitehouse MR, Blom AW, Judge A, Wilkinson JM, Sayers A. PLoS One. 2021 Aug 12;16(8):e0255602. doi: 10.1371/journal.pone.0255602

A Matched comparison of the Long-Term Outcomes of Cemented and Cementless Total Knee Replacements: An Analysis from the National Joint Registry of England, Wales, Northern Ireland and the Isle of Man. Mohammad HR, Judge A, Murray DW. J Bone Joint Surg Am. 2021 Dec 15;103(24):2270-2280. doi: 10.2106/JBJS.21.00179

A matched comparison of the patient-reported outcome measures of 38,716 total and unicompartmental knee replacements: an analysis of linked data from the National Joint Registry of England, Northern Ireland and Isle of Man and England's National PROM collection programme. Mohammad HR, Judge A, Murray DW. Acta Orthop. 2021 Dec;92(6):701-708. doi: 10.1080/17453674.2021.1956744

Trajectories of pain and function in the first five years after total hip and knee arthroplasty: an analysis of patient reported outcome data from the National Joint Registry. Dainty JR, Smith TO, Clark EM, Whitehouse MR, Price AJ, MacGregor AJ. Bone Joint J. 2021 Jun;103-B(6):1111-1118. doi: 10.1302/0301-620X.103B6.BJJ-2020-1437.R1

Metaparametric Neural Networks for Survival Analysis. de Mello FL, Wilkinson JM, Kadirkamanathan V. IEEE Trans Neural Netw Learn Syst. 2021 Oct 25;PP. doi: 10.1109/TNNLS.2021.3119510

Floor and ceiling effects in the Oxford Shoulder Score: An analysis from the National Joint Registry. Singh HP, Haque A, Taub N, Modi A, Armstrong A, Rangan A, Pandey R. Bone Joint. 2021 Nov;103-B(11):1717-1724. doi: 10.1302/0301-620X.103B11.BJJ-2021-0668.R1

Unicompartmental compared with total knee replacement for patients with multimorbidities: a cohort study using propensity score stratification and inverse probability weighting. Prats-Uribe A, Kolovos S, Berencsi K, Carr A, Judge A, Silman A, Arden N, Peterson I, Douglas IJ, Wilkinson JM, Murray D, Valderas JM, Beard DJ, Lamb SE, Ali MS, Pinedo-Villanueva R, Strauss VY, Prieto-Alhambra D. Health Technol Assess. 2021 Nov;25(66):1-126. doi: 10.3310/hta25660

Projections for primary hip and knee replacement surgery up to the year 2060: an analysis based on data from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man. Matharu GS, Culliford DJ, Blom AW, Judge A. Ann R Coll Surg Engl. 2021 Dec 23. doi: 10.1308/rcsann.2021.0206

The effect of cemented acetabular component geometry on the risk of revision for instability or loosening: a study of 224,874 primary hip arthroplasties from the National Joint Registry. Divecha HM, O'Neill TW, Lunt M, Board TN. Bone Joint J. 2021 Nov;103-B(11):1669-1677. doi: 10.1302/0301-620X.103B11.BJJ-2021-0061.R1

A matched comparison of the patient-reported outcome measures of cemented and cementless total knee replacements, based on the National Joint Registry of England, Wales, Northern Ireland, and Isle of Man and England's National PROM collection programme. Mohammad HR, Judge A, Murray DW. Acta Orthop. 2022 Jan 3;93:164-170. doi: 10.2340/17453674.2021.896

Temporal trends of primary hinge knee arthroplasty and risk factors associated with revision: National Joint Registry data from 2003 to 2018 for 4921 patients. Deehan DJ, Clement ND, Avery P, Mason J, Baker PN. Knee. 2022 Jan;34:279-287. doi: 10.1016/j.knee.2022.01.004

The association between surgeon grade and risk of revision following total hip arthroplasty: an analysis of National Joint Registry data. Fowler TJ, Aquilina AL, Reed MR, Blom AW, Sayers A, Whitehouse MR. Bone Joint J.2022 Mar;104-B(3):341-351.doi: 10.1302/0301-620X.104B3.BJJ-2021-1389.R1

The risk of all-cause mortality, heart outcomes, cancer, and neurodegenerative disorders with cobalt-chrome containing total hip replacement implants: an analysis of the National Joint Registry. Deere K, Matharu GS, Ben-Shlomo Y, Wilkinson JM, Blom AW, Sayers A, Whitehouse MR. Bone Joint J. 2022 Mar;104-B(3):359-367. doi: 10.1302/0301-620X.104B3.BJJ-2021-0397.R1

A Matched Comparison of Long-Term Outcomes of Total and Unicompartmental Knee Replacements in Different Ages Based on National Databases: Analysis of Data From the National Joint Registry for England, Wales, Northern Ireland, and the Isle of Man. Mohammad HR, Liddle AD, Judge A, Murray DW. J Arthroplasty. 2022 Feb;37(2):243-251. doi: 10.1016/j.arth.2021.09.018

UK poSt Arthroplasty Follow-up rEcommendations (UK SAFE): what does analysis of linked, routinely collected national data sets tell us about mid-late term revision risk after hip replacement? Retrospective cohort study. Smith LK, Garriga C, Kingsbury SR, Pinedo-Villanueva R, Delmestri A, Arden NK, Stone M, Conaghan PG, Judge A. BMJ Open. 2022 Mar 9;12(3):e050877. doi: 10.1136/bmjopen-2021-050877

UK poSt Arthroplasty Follow-up rEcommendations (UK SAFE): what does analysis of linked, routinely collected national datasets tell us about mid-late term revision risk after knee replacement? Smith LK, Garriga C, Kingsbury SR, Pinedo-Villanueva R, Delmestri A, Arden NK, Stone M, Conaghan PG, Judge A. BMJ Open.2022 Mar 9;12(3):e046900. doi: 10.1136/bmjopen-2020-046900

Short report: Patient Reported Outcome Measures (PROMs) in the NJR

Background

Alongside implant survivorship and post-operative mortality, the success of joint replacement surgery may be measured through Patient Reported Outcomes Measures (PROMs). PROMs seek to capture the patient perspective separately from revision and mortality outcomes. NHS England sets the strategic direction for the national PROMs programme, and is responsible for deciding what conditions and procedures should be included in the collection and what measures are used to assess the outcome following treatment. NHS Digital is commissioned by NHS England to collate, process and publish the data as 'Official Statistics'.

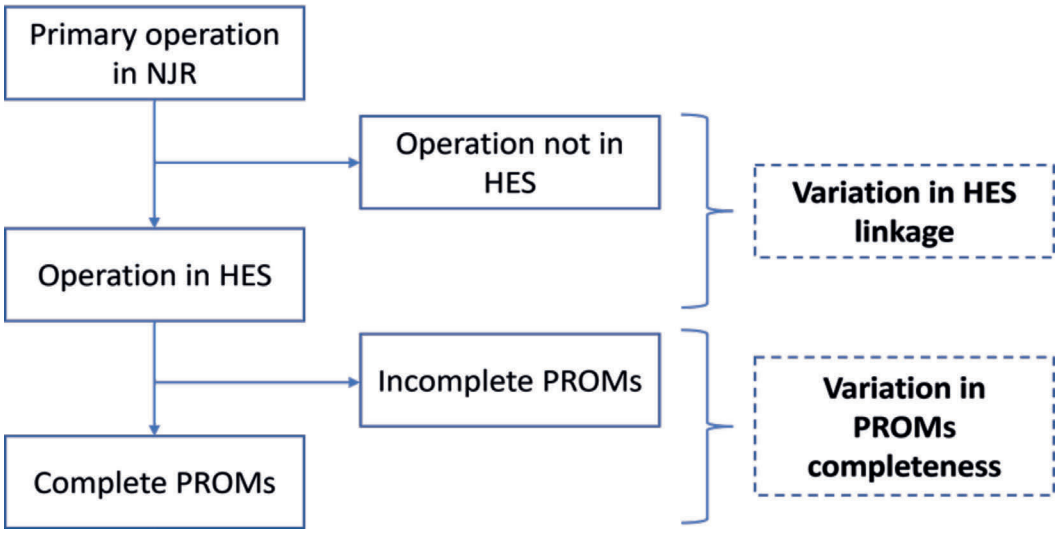
Since April 2009, all patients receiving an NHS-funded primary elective hip or knee replacement should have been invited by the trust performing their operation to complete PROMs questionnaires. The Oxford Hip/Knee scores (OHS/OKS) are recorded before and approximately six months after surgery. The OHS and OKS assess joint specific pain and function through 12 questions, which give a total possible score ranging from 0 (worst) to 48 (best), as per the reporting guidance adopted by the national PROMs programme.

This programme is separate to the NJR's data collection. National PROMs data is made available to the NJR via NHS Digital's Data Access Request Service through linkage of the patient's NJR data to the corresponding Hospital Episode Statistics (HES) record (Figure 1). The PROMs data made available to the NJR through this linkage mechanism is one of the largest collections of such data in the world. In this brief paper, we give an overview of the linkage of the NJR data with PROMs data through HES and ask the following questions:

1. How complete is the PROMs dataset?
2. Are patients with complete PROMs data representative of all patients who were eligible for the national PROMs programme in terms of a selection of patient-level characteristics, i.e. are the patients with missing PROMs data missing at random or is there a potential systematic bias associated with missingness?
3. How might PROMs data be presented in a transparent manner to report the performance at the level of implant brands?

Finally, we outline a possible reporting structure for routine inclusion of PROMs data into the NJR Annual Report in a manner that is open, transparent and informative.

Figure 1 Example flowchart of NJR -> HES -> PROMs linkage.



Methods

NJR data for primary elective total hip replacements (THRs) and total knee replacements (TKRs) from April 2009 until December 2017 that were eligible to be recorded in HES and in the national PROMs programme were linked with HES and PROMs records. Eligible records were publicly-funded operations performed in England (Figures 2 and 3).

Figure 2 Flowchart describing the study samples for primary knee replacements.

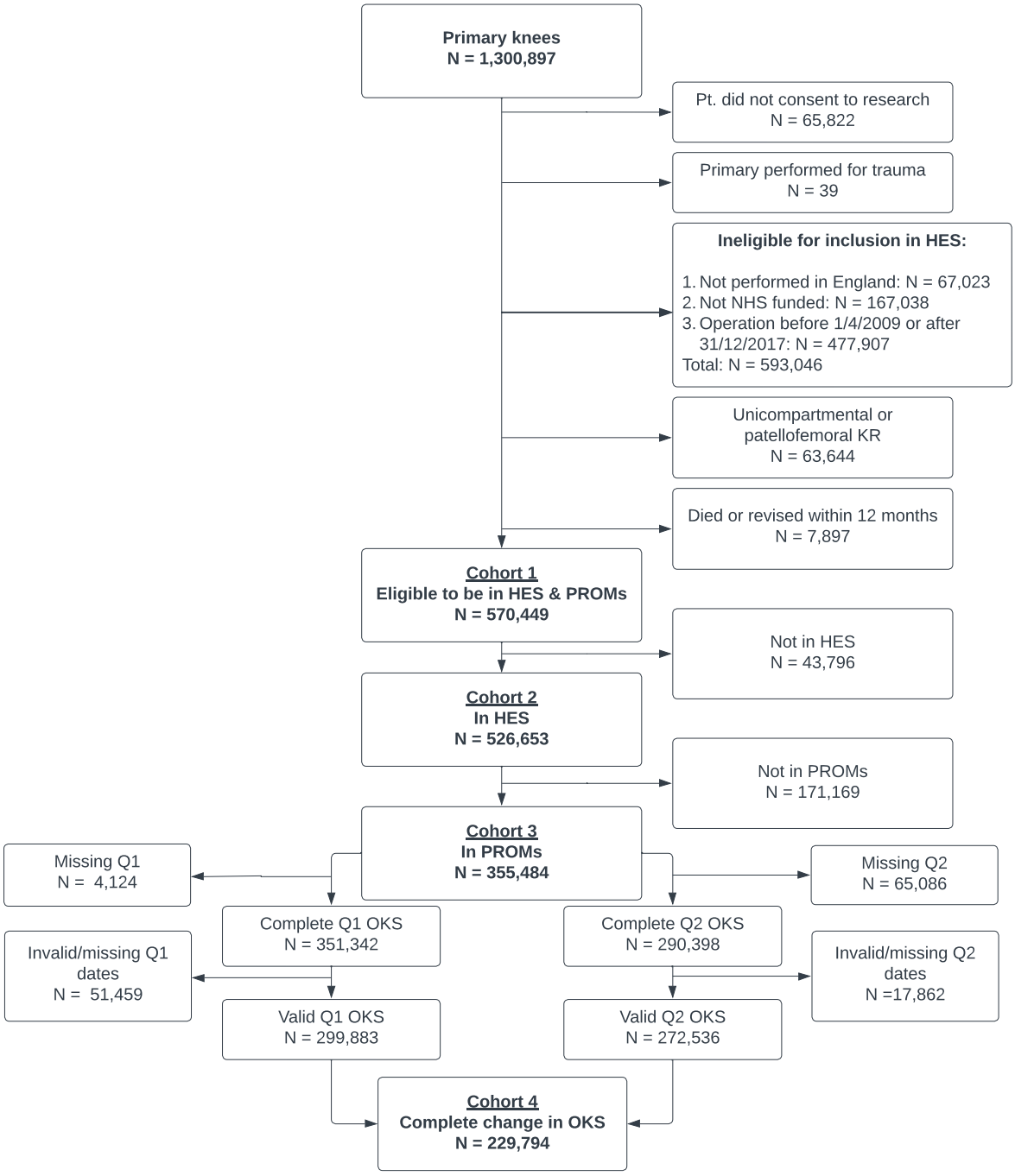
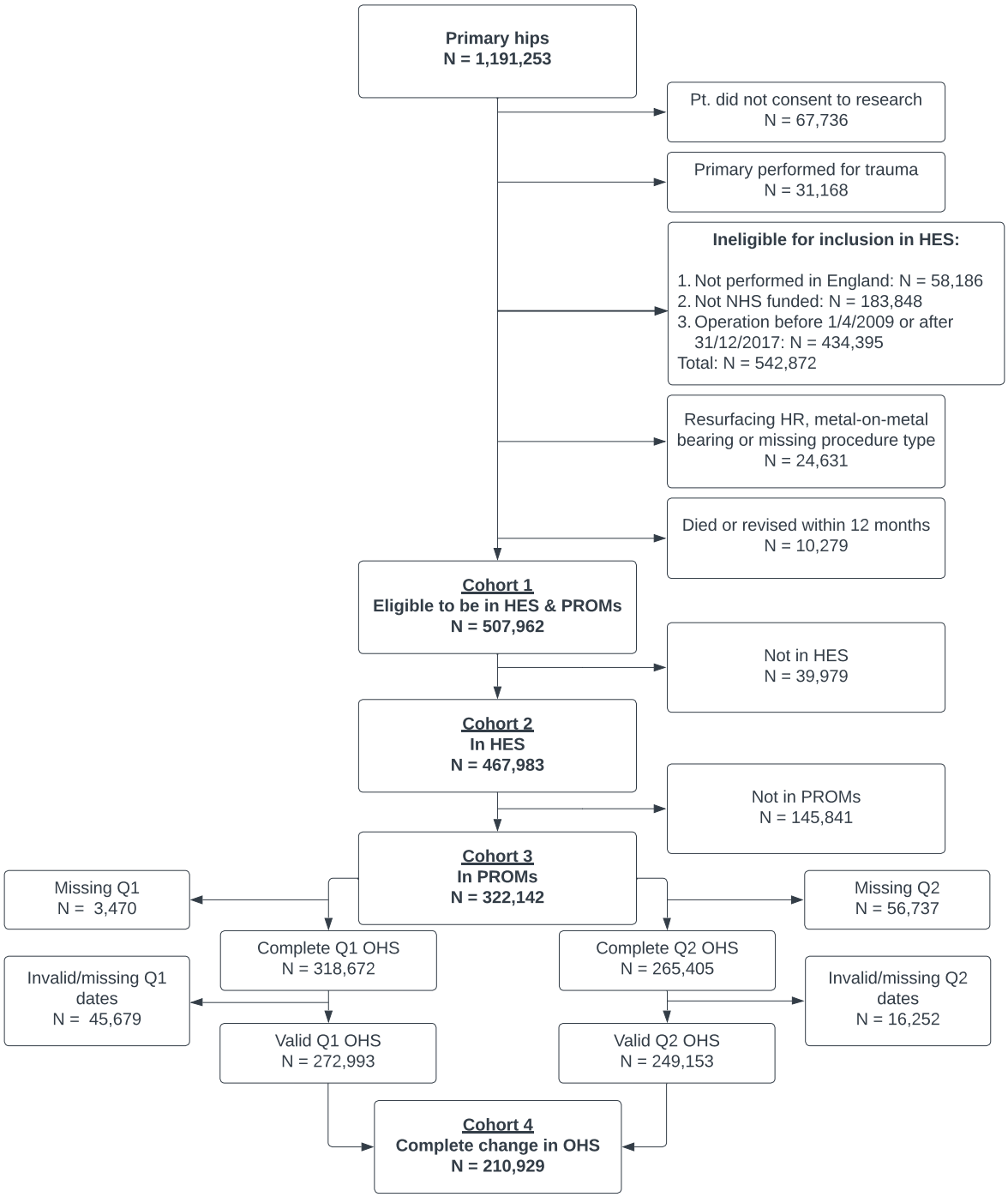


Figure 3 Flowchart describing the study samples for primary hip replacements.



PROMs completeness

Patients were allocated to one of four nested cohorts:

1. Eligible to be in the PROMs programme
2. + HES linkage
3. + pre-operative PROMs
4. + post-operative PROMs (i.e. complete PROMs data)

We considered pre-operative questionnaires to be valid if they were completed between 18 weeks pre-surgery and the day of surgery, and post-operative questionnaires that were completed between six months (national PROMs programme target) and 12 months after surgery. We excluded patients who had died or were revised within one year of their surgery, since they may not have been able to complete the PROMs or their experiences were likely to be very different from those of most patients.

Cohort comparability

We described the change over time in the proportion of potentially eligible patients (Cohort 1) in each of the subsequent cohorts and described the patients in each cohort over patient-level characteristics (age, gender, ASA grade, BMI, area deprivation score, and for hips the hip procedure type). To identify if there was any residual selection bias between patients with complete PROMs (Cohort 4) and those eligible to be included (Cohorts 1-3), we compared the revision and mortality outcomes of these two groups. Here we aimed to identify possible biases that may be associated with PROMs outcomes that were not captured by the patient-level characteristics described.

Identifying poorly performing implant constructs

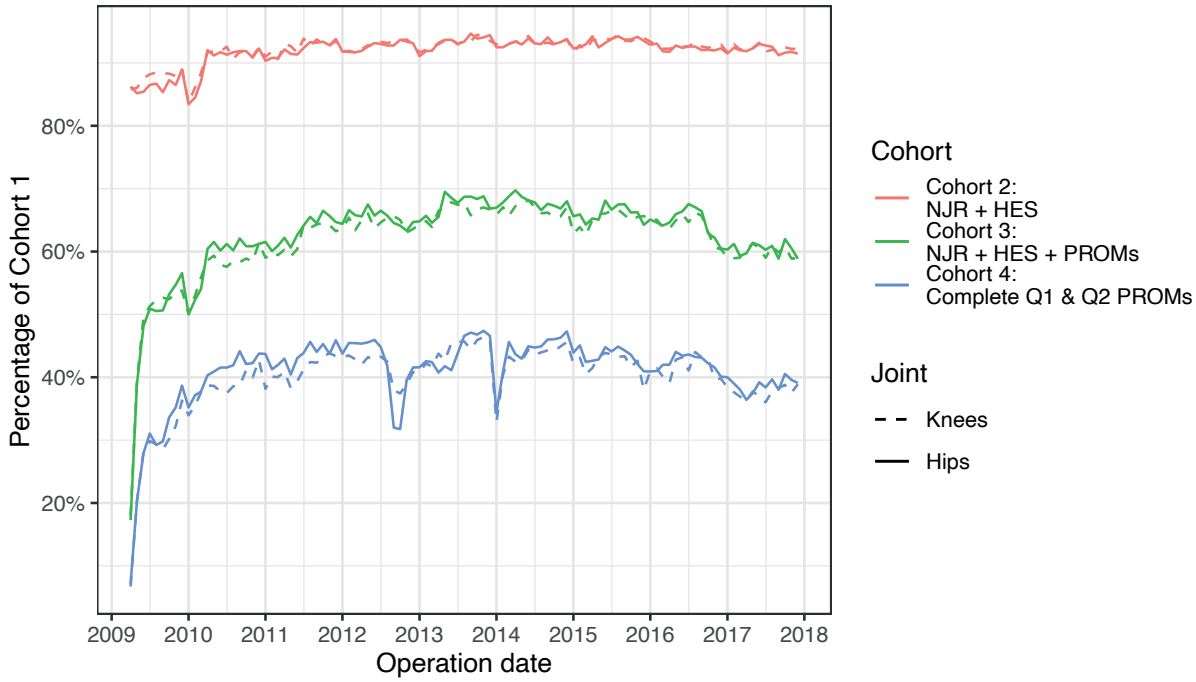
We explored the use of PROMs within a non-inferiority framework to identify implant constructs that have not met an arbitrary comparative threshold with respect to an improvement in PROMs. To do this, we calculated the PROMs improvement (post-operative minus pre-operative) and categorised this according to whether patients met or exceeded the minimally important change (MIC), the smallest change in a PROMs score interpreted by a single patient or group to be clinically meaningful. For all implant constructs we calculated the proportion of patients who met or exceeded the MIC, and the best performing implant construct used at least 1,000 times was considered the benchmark. The difference in outcome between constructs and confidence intervals from single proportion z-scores were calculated. There is no pre-existing literature to inform the acceptable range in the performance of constructs compared with the benchmark, i.e. the non-inferiority margin. We therefore arbitrarily set the range as a difference in risk of 10% for illustration purposes.

Results

PROMs completeness

A total of 570,449 elective primary TKRs and 507,962 elective primary THRs were eligible to be included in the national PROMs programme (Cohort 1, Figures 2 and 3). Of these, complete pre-operative and post-operative PROMs (Cohort 4) were available for 229,794 TKRs (40.3%) and 210,929 THRs (41.5%). From 2010 onwards >90% eligible procedures were linked with HES and this proportion remained relatively consistent and invariant between TKRs and THRs. The proportion of eligible patients (Cohort 1) who had complete pre-operative (Cohort 3) and post-operative PROMs (Cohort 4) peaked in 2014 at ~70% and ~45% respectively and has reduced to <60% and <40% for the most recent PROMs data included in this analysis and before the impact of COVID-19 (Figure 4, page 338).

Figure 4 The change in the number of patients in Cohorts 2-4 between 2009 and 2017 as a percentage of the patients potentially eligible to be included in the national PROMs programme (Cohort 1), by joint.



Cohort comparability

Patients with pre-operative PROMs (Cohort 3) were comparable with the larger cohort of eligible patients (Cohort 1) across the clinical and demographic variables included in this analysis (Tables 1 and 2, pages 339 and 340). Patients with complete PROMs (Cohort 4) had slightly lower ASA grade, were slightly older and were from less deprived areas than those with only pre-operative PROMs. Patients who had complete PROMs had a lower all-causes risk of death in the ten years after their operation (Figure 5, page 341). Compared with the wider cohort of eligible patients, 2.8% fewer TKR patients and 4.2% fewer THR patients with complete PROMs had died within ten years. However, the difference in the proportion revised by ten years was only 0.2% for THR patients and there was no difference for TKR patients, with the exclusion of those who died or were revised within one year of their primary joint replacement (Figure 6, page 342).

Table 1 Availability of HES linked and HES + PROMs linked NJR primary total knee replacements.

	Cohort 1: Whole NJR	Cohort 2: NJR + HES	Cohort 3: NJR + HES + Q1 PROMs	Cohort 4: Complete Q1 & Q2 PROMs
Characteristic	N = 570,449[1]	N = 526,653[1]	N = 355,484[1]	N = 229,794[1]
ASA grade				
P1 - Fit and healthy	49,204 (8.6%)	44,917 (8.5%)	30,775 (8.7%)	20,241 (8.8%)
P2 - Mild disease not incapacitating	421,074 (74%)	388,292 (74%)	264,549 (74%)	171,537 (75%)
P3 - Incapacitating systemic disease	98,479 (17%)	91,873 (17%)	59,235 (17%)	37,444 (16%)
P4/5 - Life threatening disease	1,692 (0.3%)	1,571 (0.3%)	925 (0.3%)	572 (0.2%)
Age at primary (years)				
<55	35,479 (6.2%)	32,783 (6.2%)	22,183 (6.2%)	11,780 (5.1%)
55 to 64	127,859 (22%)	117,751 (22%)	80,759 (23%)	50,409 (22%)
65 to 74	228,964 (40%)	210,713 (40%)	144,240 (41%)	96,892 (42%)
≥75	178,147 (31%)	165,406 (31%)	108,302 (30%)	70,713 (31%)
Gender				
Female	328,487 (58%)	303,257 (58%)	204,081 (57%)	130,349 (57%)
Male	241,962 (42%)	223,396 (42%)	151,403 (43%)	99,445 (43%)
BMI categories				
Normal weight/underweight	40,638 (9.6%)	37,359 (9.6%)	25,040 (9.3%)	16,309 (9.3%)
Overweight	141,533 (34%)	130,293 (33%)	89,717 (33%)	59,426 (34%)
Class I obesity	138,571 (33%)	128,157 (33%)	88,563 (33%)	57,805 (33%)
Class II obesity	71,357 (17%)	66,305 (17%)	45,874 (17%)	29,077 (17%)
Class III obesity	29,502 (7.0%)	27,538 (7.1%)	19,054 (7.1%)	11,929 (6.8%)
Unknown	148,848	137,001	87,236	55,248
IMD quintile (1 = most deprived)				
1	89,300 (16%)	83,354 (16%)	55,272 (16%)	32,323 (14%)
2	105,482 (19%)	97,944 (19%)	65,588 (19%)	41,134 (18%)
3	120,484 (22%)	111,175 (22%)	75,315 (22%)	49,197 (22%)
4	126,210 (23%)	116,203 (22%)	78,930 (23%)	52,664 (23%)
5	118,089 (21%)	108,334 (21%)	73,828 (21%)	50,112 (22%)
Unknown	10,884	9,643	6,551	4,364

[1]n (%)

Table 2 Availability of HES linked and HES + PROMs linked NJR hips.

	Cohort 1: Whole NJR	Cohort 2: NJR + HES	Cohort 3: NJR + HES + Q1 PROMs	Cohort 4: Complete Q1 & Q2 PROMs
Characteristic	**N = 507,962[1]**	**N = 467,983[1]**	**N = 322,142[1]**	**N = 210,929[1]**
ASA grade				
P1 - Fit and healthy	66,526 (13%)	60,848 (13%)	43,198 (13%)	28,442 (13%)
P2 - Mild disease not incapacitating	356,553 (70%)	327,845 (70%)	228,696 (71%)	150,384 (71%)
P3 - Incapacitating systemic disease	82,668 (16%)	77,213 (16%)	49,101 (15%)	31,390 (15%)
P4/P5 - Life threatening disease	2,215 (0.4%)	2,077 (0.4%)	1,147 (0.4%)	713 (0.3%)
Age at primary (years)				
<55	57,387 (11%)	52,959 (11%)	36,643 (11%)	19,384 (9.2%)
55 to 64	107,394 (21%)	98,805 (21%)	70,112 (22%)	45,581 (22%)
65 to 74	184,532 (36%)	168,989 (36%)	118,696 (37%)	81,866 (39%)
≥75	158,649 (31%)	147,230 (31%)	96,691 (30%)	64,098 (30%)
Gender				
Female	308,067 (61%)	283,595 (61%)	194,333 (60%)	126,728 (60%)
Male	199,895 (39%)	184,388 (39%)	127,809 (40%)	84,201 (40%)
BMI categories				
Normal weight/Underweight	76,375 (20%)	70,027 (20%)	48,381 (20%)	31,876 (20%)
Overweight	149,249 (40%)	137,553 (39%)	97,747 (40%)	65,310 (40%)
Class I obesity	100,547 (27%)	92,963 (27%)	65,997 (27%)	43,280 (27%)
Class II obesity	38,686 (10%)	35,941 (10%)	25,560 (10%)	16,069 (9.9%)
Class III obesity	12,840 (3.4%)	11,968 (3.4%)	8,327 (3.4%)	5,053 (3.1%)
Unknown	130,265	119,531	76,130	49,341
IMD quintile (1 = most deprived)				
1	66,465 (13%)	61,952 (14%)	41,491 (13%)	24,236 (12%)
2	86,838 (17%)	80,381 (18%)	54,904 (17%)	34,732 (17%)
3	109,133 (22%)	100,757 (22%)	69,631 (22%)	46,134 (22%)
4	118,095 (24%)	108,488 (24%)	75,380 (24%)	50,542 (24%)
5	116,780 (23%)	106,901 (23%)	74,295 (24%)	50,931 (25%)
Unknown	10,651	9,504	6,441	4,354
Hip type				
Cemented	168,734 (33%)	156,175 (33%)	104,137 (32%)	70,085 (33%)
Uncemented	211,984 (42%)	194,046 (41%)	136,959 (43%)	86,938 (41%)
Hybrid	109,996 (22%)	101,945 (22%)	70,557 (22%)	47,386 (22%)
Reverse hybrid	17,248 (3.4%)	15,817 (3.4%)	10,489 (3.3%)	6,520 (3.1%)

[1]n (%)

Figure 5 Comparison of the all-cause survival probability for patients with complete PROMs (Cohort 4) and those potentially eligible to be included in the national PROMs programme but without complete PROMs (Cohorts 1-3), by joint.

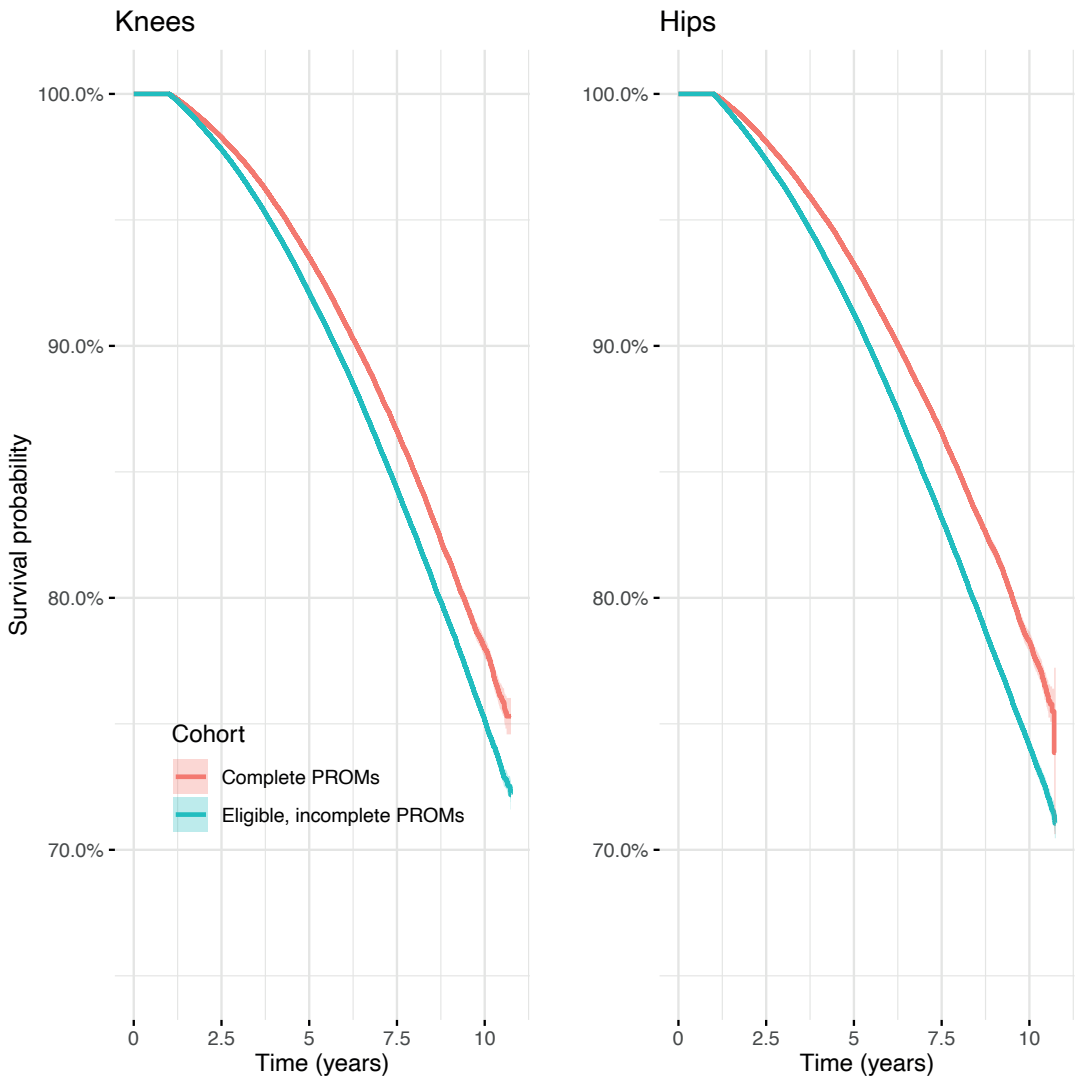
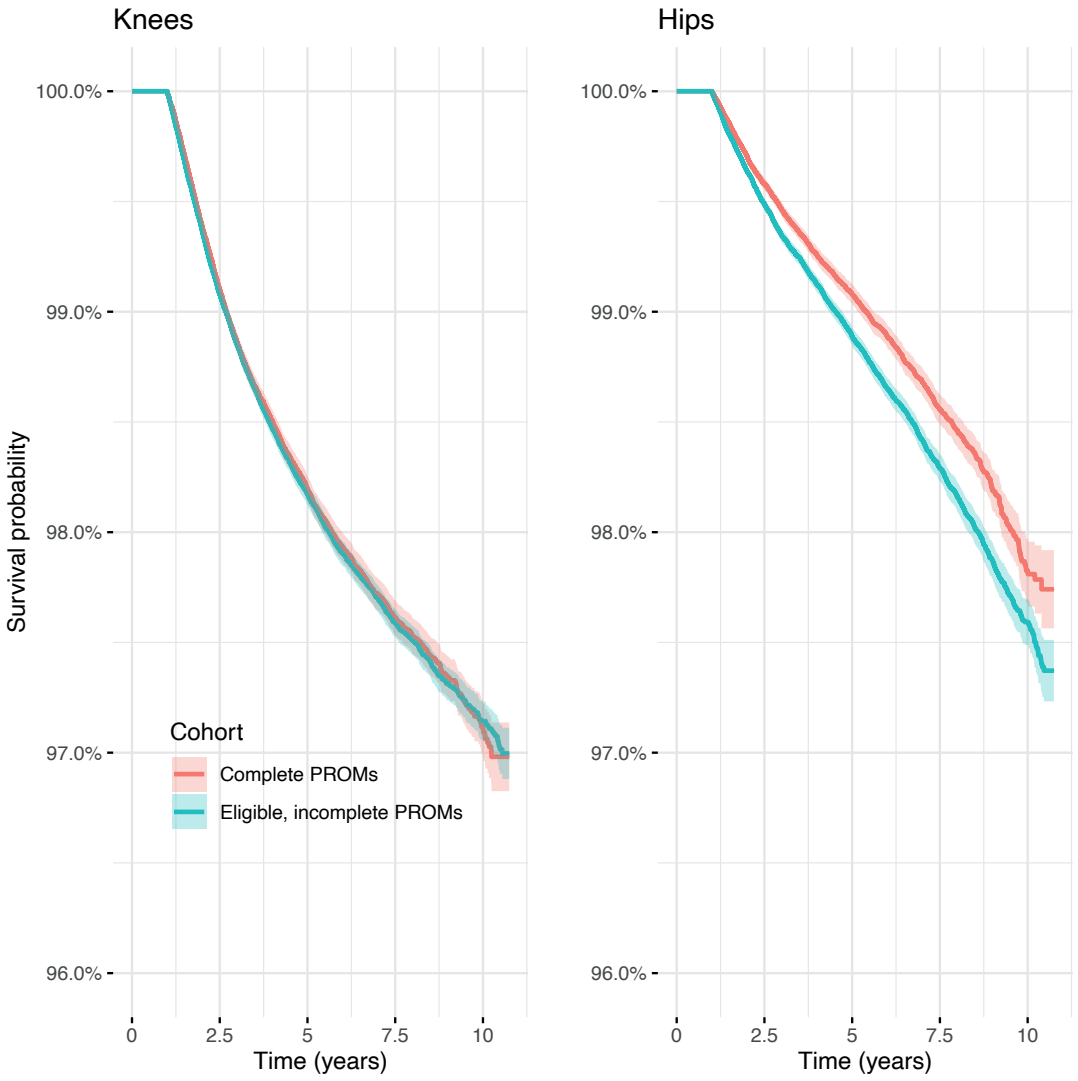


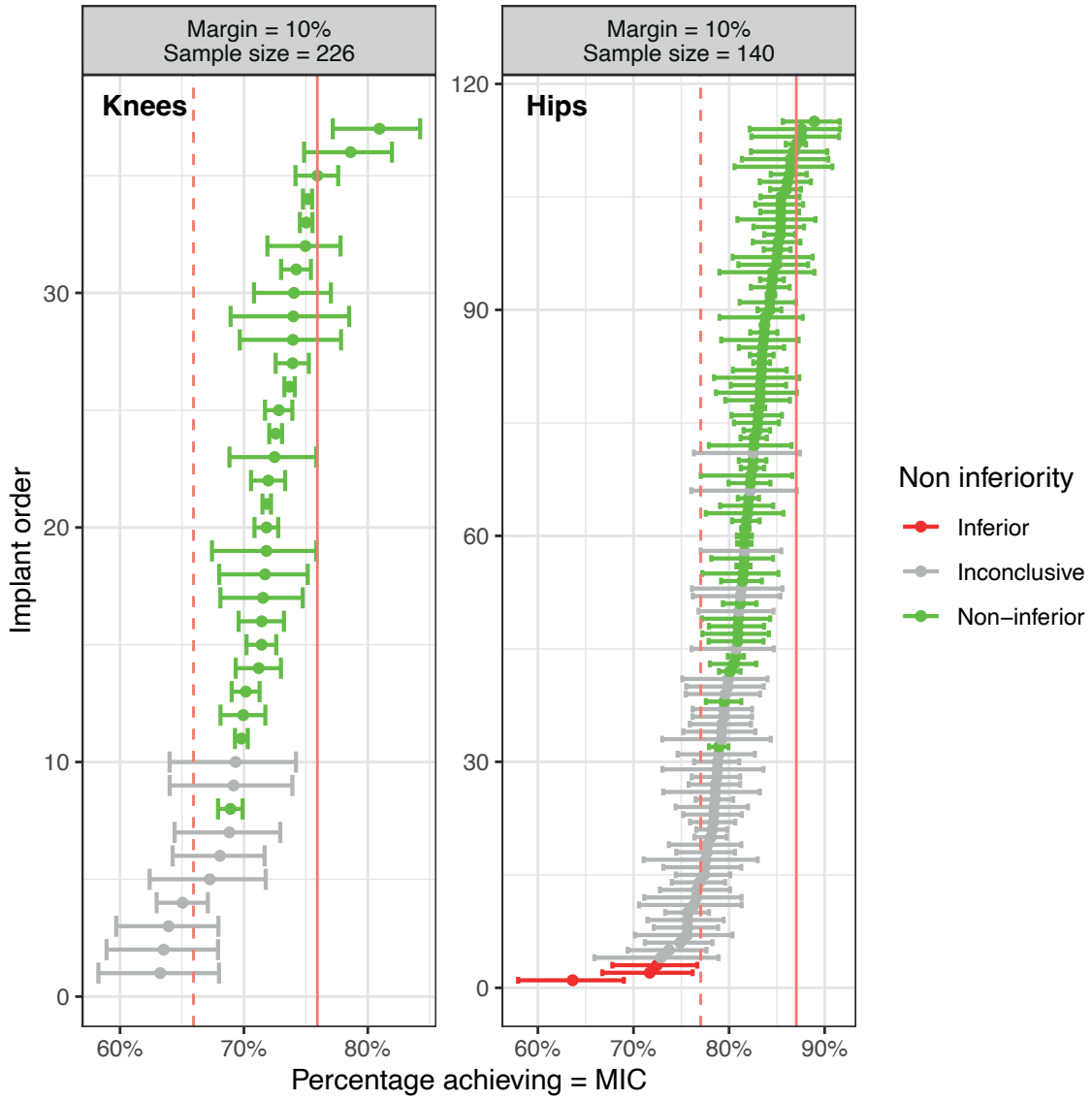
Figure 6 Comparison of prosthesis revision-free survival for patients with complete PROMs (Cohort 4) and those potentially eligible to be included in the national PROMs programme but without complete PROMs (Cohorts 1-3), by joint.



Identifying poorly performing implant constructs

The proportion of patients who achieved the MIC and received the benchmark construct were TKR: 75.9% and THR: 87.0%. Using the illustrative non-inferiority margin of 10%, no TKR constructs were classified as inferior to the benchmark construct and nine were inconclusive (24%) (Figure 7). For THRs, three constructs (3%) were classified as inferior to the benchmark, 43 were inconclusive (37%) and 69 (60%) were non-inferior to the benchmark.

Figure 7 Difference in the percentage of patients achieving the OKS MIC by knee and hip constructs compared with a contemporary benchmark with a 10% non-inferiority margin.



Discussion

The national PROMs programme was introduced in the NHS to give a measure of the success of the outcome of hip and knee replacement from the patient perspective and to give an indication of the quality of care at the provider level. Subsequent linkage to the NJR dataset has provided additional information that enables us to ask broader questions about clinical practice from the patient perspective. Further opportunity also exists to integrate the national PROMs dataset with NJR routine reporting of the performance of hip and knee replacements. However, the suitability of the data and methodology used to assess these outcomes remains unclear. To address this gap, the NJR team have been working to understand how to operationalise this process to develop a transparent, balanced and meaningful approach to reporting.

We found that despite the large proportion of patients with missing PROMs scores (approximately 60%), those with complete pre-operative and post-operative questionnaires were similar with respect to age, gender, ASA grade, BMI, and area deprivation to all patients who were eligible to be included in the national PROMs programme. However, the observed differences in mortality rates between groups suggest that patients with complete PROMs were less likely to die and therefore possibly healthier than those without complete PROMs.

Despite the size of the national PROMs programme, the generalisability limitations, as illustrated above, must be noted when considering the routine integration of PROMs into NJR reporting. National PROMs data are made available to the NJR by NHS Digital through an application process. Accessibility is subject to the same challenges of timeliness, linkage and completeness that are common to all applicants for this data. Missing data is a key challenge and there are several reasons why patients may not have PROMs records. These include system failure to request the PROMs questionnaire from the patient, incomplete and non-responses from the patient, administrative failures of processing returned questionnaires at the service-provider level, or failures / incorrect coding of PROMs responses using HES, including the subsequent deletion of identifiers which enable record-level linkage of PROMs to HES. PROMs collection may be missing systematically, as was observed by the absence of most unicompartmental knee replacements from the national PROMs programme due to the omission of common unicompartmental knee replacement procedure codes by NHS Digital. PROMs that are missing completely at random will reduce the total number of records available, but do not necessarily mean the available PROMs are biased. PROMs that are systematically missing may create a biased sample compared to that from all eligible patients. For example, ~25% of patients in the registry are missing BMI data and results derived from the linkage of national PROMs data to that of the NJR that adjust for this measure should be interpreted with caution.

In our exploratory analysis we applied a non-inferiority framework based upon comparison of an individual construct with a benchmark construct using the MIC as the outcome metric. Using this approach and a 10% threshold, we found that the vast majority of knee constructs performed similarly to the benchmark, whilst a small proportion of hip constructs would be classified as inferior. For the purposes of this analysis, we were blinded to brand names of the constructs. The face-value interpretation of this is that the vast majority of brands recorded in the NJR dataset perform similarly in respect of the proportion that achieve the MIC of the PROMs scores used. These data also suggest tighter clustering around the MIC value for knee constructs and a broader distribution of outcomes for hip constructs (at least for values below the MIC). However, the label of poor performance is entirely arbitrary and is based here upon a 10% threshold. A 5% threshold would have identified substantially more poorly-performing constructs (smaller margin = more failures), but also required a larger sample size for statistical reasons. In contrast, a 20% threshold would have likely

identified almost no poor constructs and required a smaller sample size. The graphical presentation is clear and the non-inferiority framework aligns with the question that we believe is of relevance to surgeons and patients – i.e. "Has the implant met the required performance standard?" The choice of "set-point" of desired standard reached is completely dependent upon the nature of the question being asked. The required standard and whether the information in the available PROMs and their timing of administration remain open issues for discussion. The apparent simplicity of the non-inferiority approach thus masks important limitations with respect to the design of the data collection, the design of the PROMs, the analysis of change, the volume and nature of missing data, as well as other areas of uncertainty that warrant wider discussion. Further, the choice of any margins relating to standards must be guided by the input of surgeons, patients, and manufacturers, as well as by statistical considerations.

PROMs also have inherent limitations, including their specific psychometric features. For example, PROMs may have floor and ceiling effects, less than perfect test-retest reliability, low levels of internal consistency, redundant items, poor completeness or other forms of measurement error or bias that need to be accounted for. PROMs may also fail to capture all domains of interest that are important to patients. For example, the OHS and OKS PROMs used in the national PROMs programme do not collect data on high levels of physical activity. Therefore, the data do not capture all aspects of outcome that patients or surgeons may consider important when selecting and distinguishing between implants. PROMs outcomes may also depend on external factors including, but not limited to patient, surgeon, hospital, and implant factors. The apparent simplicity of inclusion of PROMs also masks important limitations with respects to the design of the data collection, the design of the PROMs, the analysis of reported change, the volume of missing data, as well as other areas of uncertainty including the issue of causality, that all warrant further consideration.

The reporting and interpretation of PROMs in observational data, such as that collected by joint replacement registries, is challenging and there is no consensus on how this should best be done. This uncertainty begins with estimating change following surgery, it is unclear whether regression-based calculations or simple change scores will yield unbiased results. National joint replacement registers can be described, from an epidemiological perspective, as prospective longitudinal cohort studies. As such, data surrounding the exposure, i.e. receiving a joint replacement, are collected prior to experiencing the outcome. Prospective studies have a number of strengths when compared to retrospective studies, including but not limited to their potential to reduce reverse causality or minimise recall bias. However, other effects such as selection bias and confounding by indication, and missing data may still be present and cause difficulties in interpretation. Missing data is a problem in all study designs. If large proportions of patients fail to complete a PROMs questionnaire, and the reason why they do not complete it is associated with the outcome of interest, then the ability to interpret the data is compromised. The observed differences in mortality is suggestive that the national PROMs data is not missing at random. In the absence of an ability to generate unbiased estimates in this study design and the inability to demonstrate a causative link between implant brand and PROMs outcomes, directly determining implant brand performance through PROMs outcomes should be approached with caution.

Reporting suggestions

In Table 3 (page 347), we outline one possible approach to the presentation of PROMs data in the NJR Annual Report. The table is necessarily wide to ensure transparency of reporting and so is better suited for online production. The table is divided in to five vertical columns that show: the response rate, demographic characteristics, revision profile, mortality profile and PROMs outcomes of each

implant construct. Each implant brand construct is further stratified by the completeness of the PROMs response, with incomplete or ineligible responses listed below and metrics for these sub-groups calculated where appropriate. Potential biases not seen in baseline characteristics are explored through reporting of differences in revision or mortality in the longer term. Finally, PROMs scores at baseline and six months following surgery are presented. In the context of a non-inferiority analysis, if this were the preferred option of all stakeholders, alternative presentation formats to the traditional caterpillar plot could be explored for their feasibility, dependent upon data quality and consensus agreement on the most appropriate method of estimating change.

Conclusions

Further opportunity exists to integrate the national PROMs dataset with NJR routine performance reporting to add an additional dimension in our assessment of implant performance. Through inclusion of the patient perspective we hope to add increased value to the NJR dataset for all of our stakeholders. We have conducted this initial analysis and present suggestions for further consideration about the available linked data with the intention of informing discussion with relevant stakeholders about how such integration might be best achieved. Following publication of this year's NJR Annual Report we will initiate these discussions with those stakeholder groups to reach a consensus on the preferred and best reporting approach for this valuable patient perspective on the performance outcomes of joint replacement.

Table 3 Possible approach to the presentation of PROMs data in the NJR Annual Report.

Brand		Flow Chart									
		Pre-op PROMs			Alive at 180 Days	6 Month PROMs					Pre & Post
	All Cases N (England Only)	N		Pre-Op Response (%)	N=			Post-Op Response (%)		N	
	XXX	YY	Valid	X% (Denom. all Cases)	ZZZZ	AAA	Valid	B% (Denom. Alive at 180 Days)	Valid	D	F% (Denom. Alive at 180 Days)
			Invalid	Y% (Denom. all Cases)			Invalid	C% (Denom. Alive at 180 Days)	Invalid	E	G% (Denom. Alive at 180 Days)

	Demographics					Revision			
	Age	Sex	ASA	Indication	Private Funding	Time since primary			
	Mean (SD)	%	I+II%, III%, IV+V%	OA /Rheum / Other	%	3y	5y	7y	10y
Complete PROMS						XX (95% CI)			
Incomplete| Missing PROMS						XX (95% CI)			

Mortality								OHKSS PROMs			
Time since primary								Pre	Post	Change	Change adjusted for baseline
30d	90d	1y	3y	5y	7y	10y		Mean SD IQR	Mean SD IQR	Mean SD IQR	Beta
XX (95% CI)							Complete Case (D)	Based on D			
XX (95% CI)							Incomplete | Ineligible	Based on Y	Based on C	Not calc	Not calc

Case study: Using NJR data to improve patient outcomes

A case study of improving patient outcomes using data from the NJR at the South West London Elective Orthopaedic Centre

By Vipul Patel, Philip Mitchell, Deiary Kader, David Sochart and Irrum Afzal.

The South West London Elective Orthopaedic Centre (SWLEOC) is an orthopaedic surgical hub serving south west London and the neighbouring areas. The centre was established as an informal joint venture between the four local acute trusts and started functioning in 2004, initially to provide elective surgical services for patients requiring lower limb joint replacement and soft tissue knee surgery. Over the years, it has expanded to also provide services for patients requiring surgery of the shoulder or elbow, spine, hand, foot or ankle.

SWLEOC prides itself in providing an excellent patient experience. The centre hosts 49 surgeons covering different sub-specialties supported by a multi-disciplinary team and delivered over 6,000 procedures including 3,000 primary joint replacements in the 2021-22 financial year. Data from 32 lower limb joint replacement surgeons and five shoulder and elbow surgeons are submitted to the National Joint Registry (NJR). SWLEOC submits the largest volume of data to the registry (over 45,000 patients' records to date) and has consistently been accorded the status of NJR Quality Data Provider. NJR data suggests that SWLEOC has one of the lowest revision rates for knee replacements (see Figure 1, page 350).

Surgeons at SWLEOC use data from the registry and from the NJR feedback services to continuously improve patient outcomes. SWLEOC was an early adopter of the NJR's recommendation to regularly discuss the unit annual clinical report (ACR) and the consultant level reports (CLRs) provided annually by the NJR, a recommendation further reinforced by the GIRFT programme. Internal meetings are held twice a year where the SWLEOC Medical Director presents data from the ACR to identify important trends and areas for improvement. At the same meeting individual consultants present data from their CLRs, supplemented with data on complications, satisfaction and patient reported outcome measures (PROMs) collected by the SWLEOC research department. This offers the opportunity for consultants to present their data in a safe forum for discussion and, where this data does not compare favourably with that of their peers, also provides an opportunity to reflect on the reasons for this and seek constructive feedback from colleagues.

In addition, the research department at SWLEOC uses the NJR CLR data and local hospital in-house data to analyse the number of revisions and rates of revisions on a local provider level. The number of revisions of primary joint replacement cases performed at SWLEOC that have subsequently required revision either at SWLEOC or another hospital are analysed annually. The aim of this analysis is to identify surgeons who have higher than expected revision rates compared with their peers on a local level and may be approaching the NJR 'alert' or 'outlier' levels. As a result, surgeons are offered the opportunity to take measures to mitigate future revisions and subsequently reduce their revision rates.

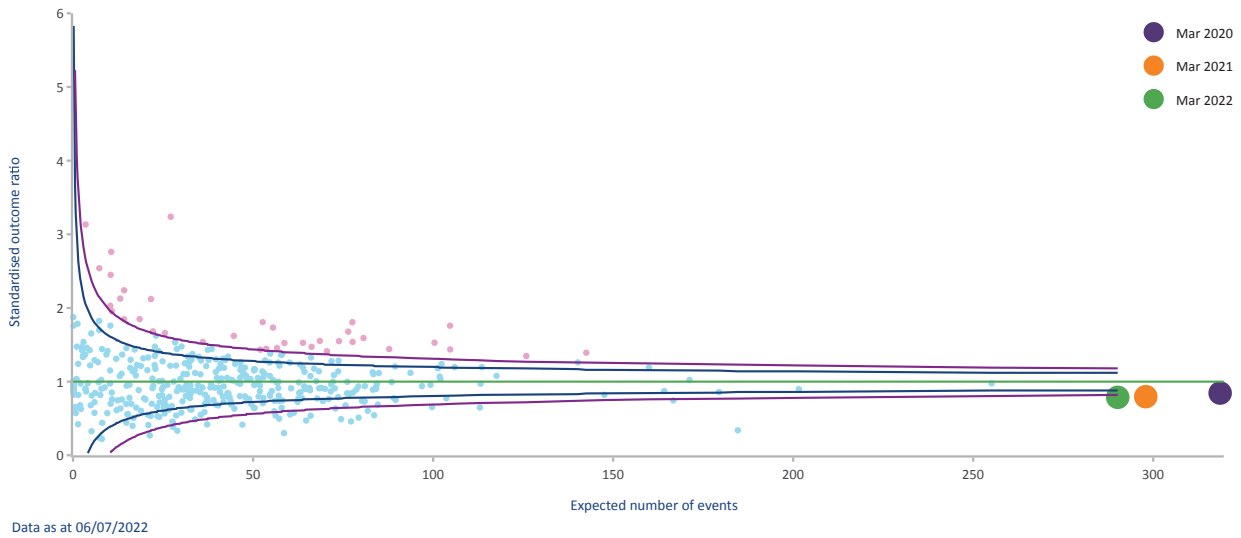
In two instances where consultants received outlier notifications from the NJR Surgical Performance Committee (SPC), the consultants concerned had already presented their data to their peer group, investigated the reasons for their higher than expected revision rates at a local level and taken steps to modify their choice of implant selection, before the Medical Director received notification from the SPC.

Following a visit from the leads of the GIRFT programme in 2016, SWLEOC was challenged regarding the relatively low proportion of patients over the age of 70 who were receiving either a hybrid or cemented total hip joint replacement, that is considered a benchmark of good practice. The Medical Director at the time brought this to the attention of colleagues and guided them in changing clinical practice. Following this initiative, there has been a year-on-year improvement in the percentage of patients over the age of 70 receiving a hybrid or cemented hip joint replacement (see Figure 2, page 351). This has been associated with a reduction in the risk of overall revisions within five years, for the patients treated at the centre from 3.33% in 2016 to 2.44% in 2021; and a steadily declining trend in the revision rates within the past ten years (Figures 3 and 4, pages 351 and 352). This initiative has not only improved long-term outcomes for the patients but also translates into more cost-effective care.

The effect of surgeon volumes on patient outcomes for specific procedures has been a topic of debate with published literature suggesting that higher-volume surgeons achieve better outcomes for specific joint replacement procedures such as unicompartmental knee replacements (UKRs). At SWLEOC, data for the number of UKRs performed by individual surgeons was gleaned from the 2021 NJR Annual Report and compared with the BASK standard in the consultants' forum. Based on a discussion led by the Medical Director, surgeons who were performing particularly low volumes of this operation were encouraged to refer their patients to colleagues who were performing higher volumes of UKRs. It is anticipated that the adoption of this best practice will translate into better outcomes for patients in the future.

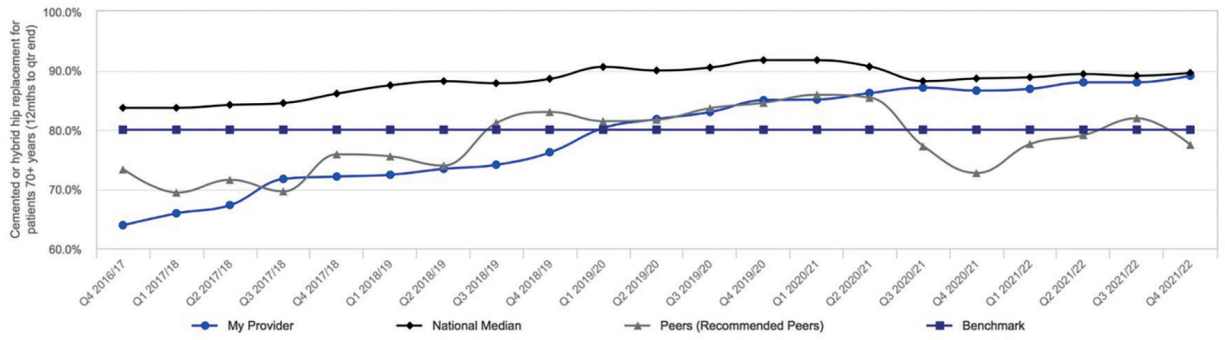
SWLEOC, as an organisation, continuously strives to use data from the NJR and other sources to improve the high quality of care and outcomes it delivers to the large volume of patients it serves and reaps the rewards of this practice through continued improved results.

Figure 1 Unit Revision Overall Knee (Last 10 years) for The South West London Elective Orthopaedic Centre



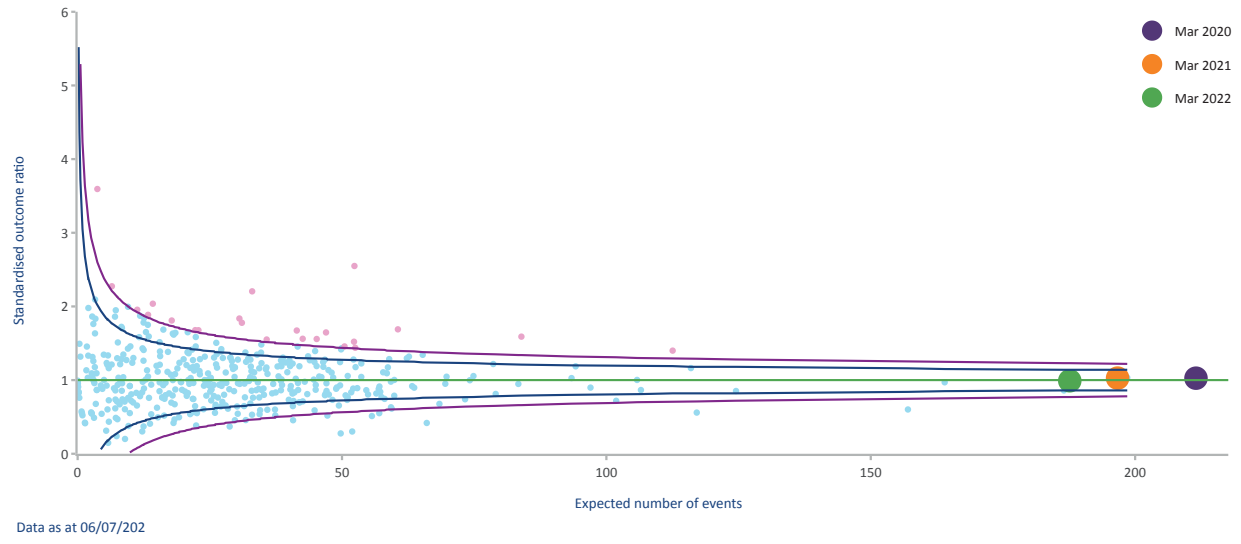
Legend: Funnel plot based on most recent data demonstrating that SWLEOC is a positive outlier for knee replacements overall (chart obtained from NJR Management Feedback system).

Figure 2 Cemented or hybrid hip replacement for patients 70+ years (12mths to qtr end). Epsom and St Helier University Hospitals NHS Trust



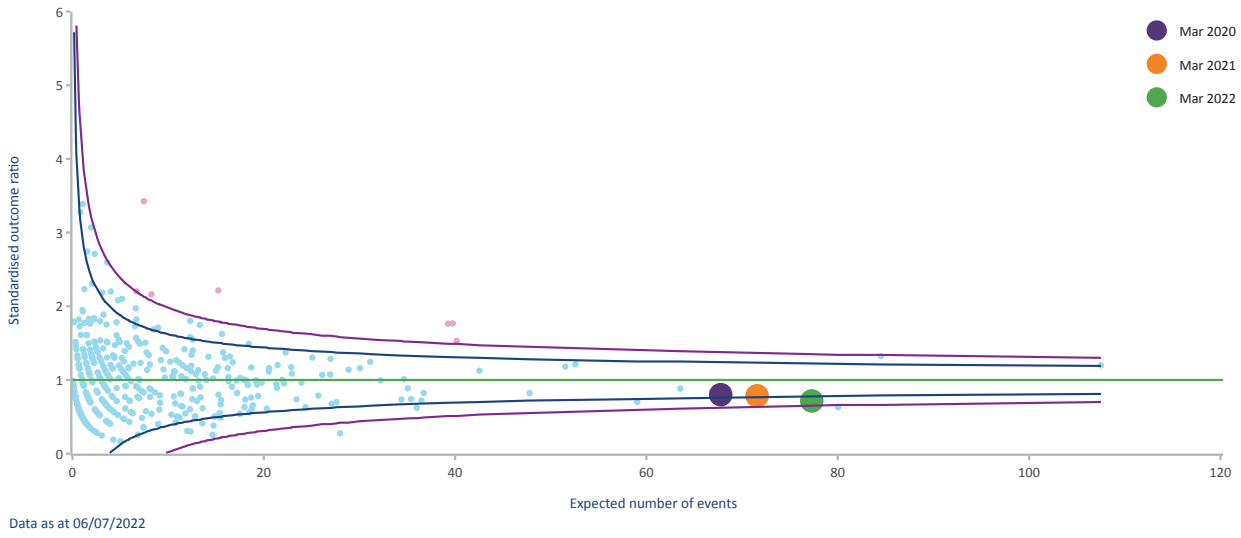
Legend: Trendline chart showing year-on-year improvements in the percentage of patients over the age of 70 years receiving cemented or hybrid hip replacements. In 2016, the figure for SWLEOC was at 60%, well below the national benchmark of 80%. By 2022, the figure for SWLEOC was 88%. (Chart from Model Hospital).

Figure 3 Unit Revision Overall Hip (Last 10 years) for The South West London Elective Orthopaedic Centre



Legend: Funnel plot demonstrating a trend of improving revision rates for all hip cases within ten years at SWLEOC (chart obtained from NJR Management Feedback system).

Figure 4 Unit Revision Hybrid Hip (Last 10 years) for The South West London Elective Orthopaedic Centre



Legend: Funnel plot demonstrating a steadily improving trend of revision rates for hybrid hips within ten years at SWLEOC (chart obtained from NJR Management Feedback system).

4. Implant and unit-level activity and outcomes

This section of the annual report gives performance and data entry quality indicators for trusts and local health boards (many of whom comprise more than one hospital) and independent (private) providers in England, Wales, Northern Ireland, the Isle of Man and Guernsey for the 2021 calendar year. Outcomes analysis after hip and knee replacement surgery is also provided for the period 2012 to 2022.

This section also provides data for implant outliers since 2003 and further information on notification and last usage date.

The full analysis for units can be found in the document available in the downloads section at reports.njrcentre.org.uk

4.1 Implant performance

The NJR Implant Scrutiny Committee reports Level 1 outlier implants to the MHRA. There are currently 10 hip stems, 11 hip acetabular (cup) components and 31 hip stem / cup combinations reported. A total of 15 knee brands are currently reported. Knee implants with and without patella resurfacing are now included in implant outlier analysis.

An implant is considered to be a Level 1 outlier when its Prosthesis Time Incident Rate (PTIR) is more than twice the PTIR of the group, allowing for confidence intervals. These are shown as the number of revisions per 100 prosthesis-years. As of March 2015, we have started to identify the best performing implants, these would have a PTIR less than half that of their group, allowing for confidence intervals. To date no implants have reached that level.

Components and constructs previously reported to MHRA, but no longer at Level 1 using the PTIR method are identified.

Hip implant performance

Table 4.1 Level 1 outlier stems reported to MHRA.

Stem name	Number implanted	Latest PTIR	Notified as outlier	Last implanted
ASR†	2,971	2.47	2010	2010
Corin Proxima*	109	2.06	2011	2009
S-ROM Cementless stem*	3,771	1.15	2013	Still in use
Adept Cementless stem*	228	1.79	2017	2010
Freeman Cementless	338	1.29	2019	2010
DePuy Proxima	341	1.25	2019	2014
Twinsys Cementless Stem	1,066	1.04	2019	2018
Alloclassic Cementless Stem*†	263	0.99	2020	2020
ESOP Stem	102	1.45	2020	2017
Bimetric Cementless Stem	4,964	0.84	February 2021	2019
SP II Cemented Revision†	124	1.39	February 2021	Still in use
CBC*	331	1.07	February 2022	2014
Aura II Cementless Stem	304	1.05	July 2022	2007

*Inclusion here is mainly due to metal-on-metal combinations.
†No longer at Level 1. The reasons for this are usually either that the metal-on-metal cases have had proportionately less contribution with time, or a reflection of the limitations of the PTIR method used over the longer term.

Table 4.2 Level 1 outlier acetabular components reported to MHRA.

Cup name	Number implanted	Latest PTIR	Notified as outlier	Last implanted
ASR*	6,355	3.52	2010	2010
Ultima MoM cup*	194	1.62	2010	2006
R3 with metal liner*	151	2.91	2011	2011
M2A38*	1,490	1.65	2014	2011
Delta One TT	589	1.38	2015	Still in use
Trabecular Metal Revision Shell	446	1.44	2017	Still in use
seleXys TH+	184	1.64	2018	2011
Pinnacle with metal liner*	15,680	1.30	2018	2013
ADES Cemented†	780	0.74	2018	2020
MIHR cup*	258	1.77	2019	2011
Bi-Mentum DM Cemented	450	1.37	February 2022	Still in use
ACE	101	3.90	July 2022	Still in use

*Inclusion here is mainly due to metal-on-metal combinations.
†No longer at Level 1. The reasons for this are usually either that the metal-on-metal cases have had proportionately less contribution with time, or a reflection of the limitations of the PTIR method used over the longer term.

Table 4.3 Level 1 outlier stem / cup combinations reported to MHRA.

Combination	Number implanted	Latest PTIR	Notified as outlier	Last implanted
ASR Resurfacing Head / ASR Resurfacing Cup*†	2,961	2.46	2010	2010
Metafix Stem / Cormet 2000 Resurfacing Cup*	173	2.35	2010	2011
CPT CoCr Stem / Adept Resurfacing Cup*	269	2.86	2011	2010
Corail / ASR Resurfacing Cup*	2,774	4.86	2011	2010
CPT CoCr Stem / BHR Resurfacing Cup*	117	2.46	2011	2010
Accolade / Mitch TRH Cup*	275	2.59	2011	2011
Summit Cementless Stem / ASR Resurfacing Cup*	129	4.35	2012	2009
CPT CoCr Stem / Durom Resurfacing Cup*	185	2.16	2012	2009
S-Rom Cementless Stem / ASR Resurfacing Cup*	150	3.44	2012	2010
CPCS / BHR Resurfacing Cup*	256	1.43	2012	2010
Anthology / BHR Resurfacing Cup*	514	2.60	2012	2011
SL-Plus Cementless Stem / Cormet 2000 Resurfacing Cup*	432	2.09	2013	2010
Profemur L Modular / Conserve Plus Resurfacing Cup*	164	2.28	2013	2010
Bimetric Cementless Stem / M2A 38*	1,303	1.68	2014	2011
Corin Proxima / Cormet 2000 Resurfacing Cup*	106	2.14	2015	2009
Synergy Cementless Stem / BHR Resurfacing Cup*	1,606	1.99	2016	2011
Adept Cementless Stem / Adept Resurfacing Cup*	201	1.91	2017	2010
Exeter V40 / Trabecular Metal Revision Shell	224	1.29	2017	2021
CLS Spotorno Cementless Stem / Adept Resurfacing Cup*	218	2.64	2017	2011
Spectron / Opera	220	1.01	2018	2014
Exeter V40 / Mitch TRH Cup*	126	1.73	2018	2010
Twinsys Cementless Stem / Adept Resurfacing Cup*	131	2.05	2018	2010
CLS Spotorno Cementless Stem / Durom Resurfacing Cup*	938	1.61	2018	2018
S-Rom Cementless Stem / Pinnacle*	2,148	1.18	2018	Still in use
S-Rom Cementless Stem / Ultima Mom Cup	105	1.40	2019	2005
Taperloc Cementless Stem / M2A 38*	139	1.45	2019	2010
Versys FMT Cementless Stem / Durom Resurfacing Cup*	189	1.35	2019	2010
Restoration Cementless Stem / Tritanium	135	2.53	June 2020	Still in use
Furlong HAC Stem / MIHR Cup	135	1.31	June 2020	2010
Bimetric Cementless Stem / Recap Magnum*†	667	0.93	February 2022	2011
C-Stem AMT Cemented Stem / Bi-Mentum DM Cemented†	230	1.95	February 2022	Still in use
Exeter V40 / G7 Cementless Acetabular Component	204	1.94	February 2022	Still in use
CBC / seleXys TH+*	102	1.33	July 2022	2011
Exeter V40 / Delta One TT	115	1.62	August 2022	Still in use

*Metal-on-metal.
†No longer at Level 1. The reasons for this are usually either that the metal-on-metal cases have had proportionately less contribution with time, or a reflection of the limitations of the PTIR method used over the longer term.

Best performing hip implants

There are no hip implants or combinations performing statistically less than half their expected PTIR.

Knee implant performance

Table 4.4 Level 1 outlier implants reported to MHRA.

Knee brand	Number implanted	Latest PTIR	Notified as outlier	Last implanted
JRI Bicondylar Knee	250	1.73	2009	2008
Tack	232	1.62	2009	2008
St Leger	104	1.68	2011	2005
Journey Deuce†	151	2.42	2014	2013
SLK Evo	106	1.85	2016	2013
ACS	204	1.47	2017	Still in use
Journey Oxinium	833	0.94	2017	2014
Noiles*	594	1.19	2018	Still in use
Smiles (METS hinged/linked knee)*	954	1.34	2018	Still in use
Endo-Model Modular Rotating Hinge*	275	1.90	2019	Still in use
Journey II BCS Oxinium without primary patella	730	1.30	June 2020	Still in use
E-Motion Bicondylar Knee with primary patella	339	1.13	June 2020	Still in use
Genesis II Oxinium without primary patella	5,488	0.78	February 2021	Still in use
LCS PFJ	225	4.65	February 2021	2010
RHK without primary patella	185	1.20	February 2021	2018
Genesis II Oxinium posterior stabilised†	3,702	0.86	July 2021	Still in use
Optetrak PS	414	0.97	August 2022	2013

*Hinged knee prostheses are more often used in complex primaries, when compared to all total knees replacements.
†No longer at Level 1. The reasons for this are usually either that the metal-on-metal cases have had proportionately less contribution with time, or a reflection of the limitations of the PTIR method used over the longer term.
Note: Analysis of knee replacements with and without patella resurfacing commenced in March 2020. Analysis by constraint (CR/PS/Constrained) commenced in March 2021.

Implants may be subjected to closer scrutiny under certain conditions, such as when reports are received from surgeons concerned about the performance of certain variants, or when a device seems to have a very specific mode of failure. Kaplan-Meier analysis of revision rate is performed, using the average for all knees recorded in the NJR as the "expected" value, and if necessary followed up with other statistical tests.

If a variant is found to be significantly ($p<0.001$) outside the expected range, then this is also reported to the company and the MHRA. As a consequence of this the committee has reported two specific variants in the NexGen total knee replacement brand. These are combinations of the Option cemented (non-precoat) tibial implant, specifically when used in conjunction with the posterior stabilised Flex femoral components (Flex and Flex GSF). These combinations have been used in approximately 6% of all cases (approximately 13% of all posterior stabilised variants) of the NexGen implantations within the areas that the NJR covers.

All other NexGen constructs were similarly examined in detail and not found to be significantly outside of the expected performance, indeed some were found to perform better than expected, especially among the cruciate retaining variants.

The NJR is currently undertaking similar investigations of other devices and will report any adverse findings to the clinical community should any be identified. Any surgeons who have specific concerns about the performance of joint replacement implants and/or specific variants that would benefit from closer examination, can contact the NJR Implant Scrutiny Committee at njr@njr.org.uk.

Best performing knee implants

There are no knee implants performing statistically less than half their expected PTIR.

4.2 Clinical activity

Overall in 2021, 139 NHS trusts and local health boards (comprising 253 separate hospitals) and 176 independent hospitals were open and eligible to report patient procedures to the registry. Data were not submitted in 2021 by nine NHS hospitals and three independent hospitals.

Of those hospitals submitting data, the proportion of patients who gave permission (consent) for their details to be entered into the registry were:

NHS hospitals

- 39% of NHS hospitals achieved a consent rate of greater than 95%
- 34% achieved a consent rate of 80% to 95%
- 28% recorded a consent rate of less than 80%

Independent hospitals

- 58% of independent hospitals achieved a consent rate greater than 95%
- 27% achieved a consent rate of 80% to 95%
- 14% recorded a consent rate of less than 80%

There has been an increase in recorded consent for all submitting units when compared to the previous year, with those achieving a higher than 95% rate rising to 47%, from 43% in 2020 (56% in 2019). The proportion of all units achieving higher than 80% also increased slightly. The reduction in consent rate since 2019 can be related to the ratio of elective to trauma cases, which changed significantly during 2020, having a higher proportion of trauma cases compared to previous years. There was a significant reduction in elective cases due to COVID-19 and trauma cases have a higher rate where NJR consent is not obtained.

Similarly, the proportion of entries in which there is significant data to enable the patient to be linked to an NHS number (linkability) is listed.

NHS hospitals

- 77% achieved a proportion of patients with a linkable NHS number greater than 95%
- 18% achieved a proportion of 80% to 95%
- 5% recorded a proportion of less than 80%

Independent hospitals

- 73% achieved a proportion of patients with a linkable NHS number greater than 95%
- 23% achieved a proportion of 80% to 95%
- 4% recorded a proportion of less than 80%

In 2021, 76% of all submitting units achieved over 95% linkability, maintaining the rate seen in 2020 (80% in 2019). Units achieving 80 to 95% linkability also remained the same at 20%.

Note: Independent hospitals might be expected to have lower linkability rates than NHS hospitals, as a proportion of their patients may come from overseas and do not have an NHS number.

4.3 Outlier units for 90-day mortality and revision rates for the period 2012 to 2022

The observed numbers of revisions of hip and knee replacements for each hospital were compared to the numbers expected, given the unit's case-mix in respect of age, gender and reason for primary surgery. Hospitals with a much higher than expected revision rate for hip and knee replacement have been identified. These hospitals had a revision rate that was above the upper of the 99.8% control limits (these limits approximate to +/-3 standard deviations). We would expect 0.2% (i.e. one in 500) to lie outside the control limits by chance, with approximately half of these (one in 1,000) to be above the upper limit.

When examined over the past ten years of the registry, a total of 37 hospitals reported higher than expected rates of revision for knee replacement, and 23 hospitals had higher than expected rates of revision for hip surgery. However, revisions taken only from the last five years of the registry showed only 15 hospitals reporting higher than expected rates for knees, and 10 for hips.

The 90-day mortality rate for primary hip and knee replacement was calculated using the last five years of

data for all hospitals by plotting standardised mortality ratios for each hospital against the expected number of deaths. No hospitals had higher than expected mortality rates for either hip or knee replacement.

Note: The case mix for mortality includes age, gender and ASA grade. Trauma cases have been excluded from both the hip and knee mortality analyses together with hips implanted for failed hemi-arthroplasty or for metastatic cancer (the latter only from November 2014 when recording of this reason began). Also, where both left and right side joints were implanted on the same day, only one side was included in the analysis.

Note: Any units identified as potential outliers here have been notified. All units are provided with an NJR Annual Clinical Report and additionally have access to the online NJR Management Feedback system.

Important note about the outlier hospitals listed

In earlier annual reports, we reported outlying hospitals based on all cases submitted to the registry since 1 April 2003. To reflect changes in hospital practices and component use, we now report outlying hospitals based on the last ten years (11 February 2012 to 11 February 2022) and five years of data (10 February 2017 to 11 February 2022 inclusive, the latter date being when the dataset was cut). These cuts of data exclude the majority of withdrawn outlier implants and metal-on-metal total hip replacements from analysis, and thus better represent contemporary practice.

Table 4.5 Outliers for hip mortality rates since 2017[2].

Hospital name
None identified

Table 4.6 Outliers for knee mortality rates since 2017[2].

Hospital name
None identified

Table 4.7 Outliers for hip revision rates, all linked primaries from 2012[1].

Hospital name
Basingstoke and North Hampshire Hospital
Broadgreen Hospital
Clementine Churchill Hospital (Middlesex)
Fitzwilliam Hospital (Cambridgeshire)
Hexham General Hospital
Homerton University Hospital
Hull Royal Infirmary
Meriden Hospital (West Midlands)
Milton Keynes Hospital
North Tyneside General Hospital
Nuffield Health Cheltenham Hospital (Gloucestershire)
Nuffield Orthopaedic Centre
Orthopaedics and Spine Specialist Hospital (Cambridgeshire)
Salisbury District Hospital
Southampton General Hospital
Spire Hartswood Hospital (Essex)
Spire Liverpool Hospital (Merseyside)
Spire Methley Park Hospital (West Yorkshire)
St Richard's Hospital
The Tunbridge Wells Hospital
Wansbeck Hospital
Weston General Hospital
York Hospital

Table 4.8 Outliers for hip revision rates, all linked primaries from 2017[2].

Hospital name
Broadgreen Hospital
Darent Valley Hospital
Hexham General Hospital
King Edward VII's Hospital Sister Agnes (Greater London)
Milton Keynes Hospital
North Tyneside General Hospital
Nuffield Orthopaedic Centre
Princess of Wales Hospital
Wansbeck Hospital
Weston General Hospital

Table 4.9 Outliers for knee revision rates, all linked primaries from 2012[1].

Hospital name
Ashford Hospital
Bath Clinic (Avon)
Bishops Wood Hospital (Middlesex)
BMI The South Cheshire Private Hospital (Cheshire)
Broadgreen Hospital
County Hospital Louth
Ealing Hospital
Goring Hall Hospital (West Sussex)
Guy's Hospital
Heatherwood Hospital
Hillingdon Hospital
Hinchingbrooke Hospital
Hospital of St John and St Elizabeth (Greater London)
King Edward VII's Hospital Sister Agnes (Greater London)
London Independent Hospital (Greater London)
Meriden Hospital (West Midlands)
Mount Vernon Treatment Centre
Nevill Hall Hospital
Nuffield Health Haywards Heath Hospital (West Sussex)
Nuffield Orthopaedic Centre
Orthopaedics and Spine Specialist Hospital (Cambridgeshire)
Practice Plus Group Hospital - Southampton (Hampshire)
Princess Royal Hospital
Scarborough General Hospital
South Tyneside District Hospital
Southampton General Hospital
Southmead Hospital
Spire Hull and East Riding Hospital (East Yorkshire)
Spire Southampton Hospital (Hampshire)
Springfield Hospital (Essex)
St Mary's Hospital (Isle of Wight)
St Richard's Hospital
Sussex Orthopaedic NHS Treatment Centre
The Royal National Orthopaedic Hospital (Stanmore)
Torbay Hospital
University Hospital Llandough
York Hospital

Table 4.10 Outliers for knee revision rates, all linked primaries from 2017[2].

Hospital name
Ashford Hospital
Bath Clinic (Avon)
Guy's Hospital
Hillingdon Hospital
King Edward VII's Hospital Sister Agnes (Greater London)
Mount Vernon Treatment Centre
Nuffield Orthopaedic Centre
Queen Elizabeth The Queen Mother Hospital
Southmead Hospital
Spire Bushey Hospital (Hertfordshire)
Spire Southampton Hospital (Hampshire)
Springfield Hospital (Essex)
Sussex Orthopaedic NHS Treatment Centre
St Mary's Hospital (Isle of Wight)
Yeovil District Hospital

Note: 1 Date range 11 February 2012 to 11 February 2022 inclusive.
2 Date range 10 February 2017 to 11 February 2022 inclusive.

4.4 Better than expected performance

This year we have again listed hospitals where revision rates are statistically better than expected. The lists here show units that lie below the 99.8% control limit which also achieved greater than 90% compliance across all of the NJR data quality audits. Units with lower data quality compliance are automatically excluded from these lists.

Table 4.11 Better than expected hip revision rates, all linked primaries from 2012[1].

Hospital name
Calderdale Royal Hospital
Goring Hall Hospital (West Sussex)
Ipswich Hospital
Musgrave Park Hospital
Royal Surrey County Hospital
Russells Hall Hospital
Sunderland Royal Hospital
Ulster Independent Clinic (Belfast)

Table 4.12 Better than expected hip revision rates, all linked primaries from 2017[2].

Hospital name
Ipswich Hospital

Table 4.13 Better than expected knee revision rates, all linked primaries from 2012[1].

Hospital name
Bishop Auckland Hospital
Burnley General Hospital
Craigavon Area Hospital
Hexham General Hospital
Ipswich Hospital
Musgrave Park Hospital
Norfolk and Norwich Hospital
North Tyneside General Hospital
Nottingham Woodthorpe Hospital (Nottinghamshire)
Nuffield Health Cambridge Hospital (Cambridgeshire)
Nuffield Health Derby Hospital (Derbyshire)
Nuffield Health Ipswich Hospital (Suffolk)
Nuffield Health Wolverhampton Hospital (West Midlands)
Practice Plus Group Hospital - Emersons Green (Avon)
Princess Alexandra Hospital
Rotherham District General Hospital
Spire Leicester Hospital (Leicestershire)
Spire Norwich Hospital (Norfolk)
Spire Parkway Hospital (West Midlands)
Stepping Hill Hospital
The Elective Orthopaedic Centre
The Horder Centre (East Sussex)

Table 4.14 Better than expected knee revision rates, all linked primaries from 2017[2].

Hospital name
None identified

Note: 1 Date range 11 February 2012 to 11 February 2022 inclusive.
2 Date range 10 February 2017 to 11 February 2022 inclusive.

Glossary

A	
ABHI	Association of British HealthTech Industries – the UK trade association of medical device suppliers.
Acetabular component	The portion of a total hip replacement prosthesis that is inserted into the acetabulum – the socket part of a ball and socket joint.
Acetabular cup	See Acetabular component.
Acetabular prosthesis	See Acetabular component.
Administrative censoring	Administrative censoring is the process of defining the end of the observation period for the cohort. All patients are assumed to have experienced either a revision, be dead or alive and unrevised at the censoring date.
ALVAL	Aseptic Lymphocyte-dominated Vasculitis-Associated Lesion. This term is used in the Annual Report to describe the generality of adverse responses to metal debris, but in its strict sense refers to the delayed type-IV hypersensitivity response.
Amputation	The surgical removal of a limb or part of a limb.
Antibiotic-loaded bone cement	A bone cement which contains pre-mixed antibiotics, this is distinct from plain bone cement which contains no antibiotics. See Bone cement.
Arthrodesis	A procedure where the bones of a natural joint are fused together (stiffened).
Arthroplasty	A procedure where a native joint is surgically reconstructed or replaced with an artificial prosthesis.
ASA	American Society of Anesthesiologists scoring system for grading the overall physical condition of the patient, as follows: P1 – fit and healthy; P2 – mild disease, not incapacitating; P3 – incapacitating systemic disease; P4 – life threatening disease; P5 – expected to die within 24 hrs without an operation.
B	
BASK	British Association for Surgery of the Knee.
Bearing type	The two surfaces that articulate together in a joint replacement. Options described in the report include metal-on-polyethylene, metal-on-metal, ceramic-on-polyethylene, ceramic-on-metal, ceramic-on-ceramic and in dual mobility hip replacements metal-on-polyethylene-on-metal and ceramic-on-polyethylene-on-metal.
BESS	British Elbow and Shoulder Society.
Beyond Compliance	A system of post market surveillance initiated in 2013. Under this system, Beyond Compliance collates NJR data, national PROMs and data from implanting surgeons, and monitors the usage and performance of implants which are new to the market.
BHS	British Hip Society.
Bilateral operation	Operation performed on both sides, e.g. left and right knee procedures, carried out on the same day or on different days.
BOA	British Orthopaedic Association. The surgical specialty association for trauma and orthopaedics in the UK.
Body mass index (BMI)	A statistical tool used to estimate a healthy body weight based on an individual's height. The BMI is calculated by dividing a person's weight (kg) by the square of their height (m^2).
BOFAS	British Orthopaedic Foot and Ankle Society.
Bone cement	The material used to fix cemented joint replacements to bone – polymethyl methacrylate (PMMA).
BOTA	British Orthopaedic Trainees Association.
Brand (of prosthesis)	The brand of a prosthesis (or implant) is the manufacturer's product name, e.g. the Exeter V40 brand for hips, the PFC Sigma brand for knees, the Zenith brand for ankles, the Delta Xtend brand for shoulders and the Coonrad Morrey for elbows.

C	
Case ascertainment	Proportion of all relevant joint replacement procedures performed that are entered into the NJR.
Case mix	Term used to describe variation in surgical practice, relating to factors such as indications for surgery, patient age and gender.
Ceiling effect	A measurement limitation of an outcome measure where the highest possible score or close to the highest score of a measurement instrument is reached, making differentiation not possible within that group, or this may reflect that the intended domain has not been accurately measured by the instrument. There is no consensus on the proportion of individuals that need to fall into this group or whether it should only apply for the highest score or also to those close to the highest score. See also Floor effect.
Cement	See Bone cement.
Cemented	Prostheses designed to be fixed into the bone using bone cement.
Cementless	See Uncemented.
Compliance	The percentage of total joint procedures that have been entered into the registry where the denominator is defined as the number of all eligible procedures.
Confidence Interval (CI)	A 'Confidence Interval' (CI) illustrates the uncertainty of an estimated statistic. For example, a CI for the cumulative probability of revision tells us the probability that 'true' (population) probability of revision will fall between the range of values on a specified percentage, typically 95%, of occasions if the data collection was repeated.
Confounding	Confounding occurs when either a measured or unmeasured factor (variable) distorts the true relationship between the exposure and outcome of interest. For example, a comparison of the revision rates between two distinct types of implant may be 'confounded' because one implant has been used on an older group of patients compared to the other. In this context, age may be a 'confounder' if it distorts the relationship between implant type and outcome i.e. revision rate. Statistical methods may help to 'adjust' for such confounding factors however residual confounding of an association may always persist.
Conventional total shoulder replacement	Replacement of the shoulder joint which replicates the normal anatomical features of a shoulder joint.
Coverage	Scope of inclusion criteria for the registry. Data submission has been mandatory for independent organisations since 1 April 2003 and for NHS organisations since 1 April 2011. See also NJR definition.
COVID-19	Coronavirus disease following infection from the SARS-CoV-2 virus.
Cox 'proportional hazards' model	A type of multivariable regression model used in survival analysis to look at the effects of a number of variables ('exposures') on outcome (first revision or death). The effect of each variable is adjusted for the effects of all the other 'exposure' variables in the model. Some regression models used in survival modelling make assumptions about the way the hazard rate changes with time (see 'hazard rate'). The Cox model doesn't make any assumptions about how the hazard rate changes, however it does assume that the exposure variables affect the hazard rates in a 'proportional' way.
CQC	Care Quality Commission. Regulators of care provided by the NHS, local authorities, private companies and voluntary organisations.
Cumulative Incidence Function (CIF)	A different way of estimating failure compared to Kaplan-Meier, see Kaplan-Meier. Also known as observed or crude failure, as the estimate reflects what is seen in practice.
Cup	See Acetabular component.

D	
DAIR	Debridement And Implant Retention. In cases of infection, the surgeon may debride (surgically clean) the surgical site and retain the joint replacement implants. The NJR does not collect data on Antibiotic use and therefore DAIR in our context focuses on implant and procedure data.
DAIR with Modular Exchange	Debridement And Implant Retention with Modular Exchange. In cases of infection where the implants are modular, the surgeon may debride (surgically clean) the surgical site, exchange the modular components (e.g. head, acetabular liner) and retain the non-modular joint replacement implants.
Data collection periods for annual report analysis	Outcomes analyses present data for hip, knee, ankle, elbow and shoulder procedures that took place between 1 April 2003 and 31 December 2021 inclusive. Hospital (unit) level analyses present data for hip and knee procedures undertaken between 1 January and 31 December 2021 inclusive. Online interactive reporting presents data for each calendar year - 1 January to 31 December inclusive. Hospital (unit) outlier analysis is performed on the last five and ten years of data up to 11 February 2022.
DDH	Developmental dysplasia of the hip. A condition where the hip joint is malformed, usually with a shallow socket (acetabulum), which may cause instability.
Distal humeral hemiarthroplasty	A type of elbow replacement which only replaces the distal part of the humerus.
DHSC	Department of Health and Social Care.
Dual mobility	Dual mobility is a type of total hip replacement which contains two articulating bearing surfaces. The distal bearing surface consists of a standard femoral head which articulates within a large polyethylene bearing. The proximal bearing surface consists of an acetabular bearing which articulates against a large polyethylene bearing. The femoral head and acetabular bearing can be made of metal or ceramic.
DVT	Deep vein thrombosis. A blood clot that can form in the veins of the leg and is recognised as a significant risk after joint replacement surgery.
E	
Episode	An event involving a patient procedure such as a primary or revision total prosthetic replacement. An episode can also consist of two consecutive procedures, e.g. a stage one of two-stage revision, followed by a stage two of two-stage revision.
Excision arthroplasty	A procedure where the articular ends of the bones are simply excised, so that a gap is created between them, or when a joint replacement is removed and not replaced by another prosthesis.
F	
Femoral component (hip)	Part of a total hip joint that is inserted into the femur (thigh bone) of the patient. It normally consists of a stem and head (ball).
Femoral component (knee)	Portion of a knee prosthesis that is used to replace the articulating surface of the femur (thigh bone).
Femoral head	Spherical portion of the femoral component of the artificial hip replacement. May be modular or non-modular i.e. attached to the stem, see monobloc.
Femoral prosthesis	Portion of a total joint replacement used to replace damaged parts of the femur (thigh bone).
Femoral stem	The part of a modular femoral component inserted into the femur (thigh bone). It has a femoral head mounted on it to form the complete femoral component in hip replacement or may be added to the femoral component of a total knee replacement, usually in the revision setting.
Floor effect	A measurement limitation of an outcome measure where the lowest possible score or close to the lowest score of a measurement instrument is reached making differentiation not possible within that group, or this may reflect that the intended domain has not been accurately measured by the instrument. There is no consensus on the proportion of individuals that need to fall into this group, or whether it should only apply for the lowest score or also to those close to the lowest score. See also Ceiling effect.
Funnel plot	A graphical device to compare unit or surgeon performance. Measures of performance (e.g. a ratio of number of observed events to the expected number based on case-mix) are plotted against an interpretable measure of precision. Control limits are shown to indicate acceptable performance. Points outside of the control limits suggest 'special cause' as opposed to 'common cause' variation (see for example D Spiegelhalter, Stats in Medicine, 2005).

G	
Glenoid component	The portion of a total shoulder replacement prosthesis that is inserted into the scapula – the socket part of a ball and socket joint in conventional shoulder replacement or the ball part in reverse shoulder replacement.
H	
Hazard rate	Rate at which 'failures' occur at a given point in time after the operation conditional on 'survival' up to that point. In the case of first revision, for example, this is the rate at which new revisions occur in those previously unrevised.
Head	See Femoral head and/or Humeral head and/or Radial head component (elbow).
Healthcare provider	NHS or independent sector organisation that provides healthcare; in the case of the NJR, orthopaedic hip, knee, ankle, elbow or shoulder replacement surgery.
HES	Hospital Episode Statistics. A data source managed by NHS Digital which contains data on conditions (ICD-10 codes), procedures (OPCS-4 codes) in addition to other hospital statistics collected routinely by NHS hospitals in England.
Highly cross-linked polyethylene	See Modified Polyethylene.
HQIP	Healthcare Quality Improvement Partnership. Hosts the NJR on behalf of NHS England/Improvement. Promotes quality in health and social care services and works to increase the impact that clinical audit has nationally.
Humeral component (elbow/distal)	Part of a total elbow joint that is inserted into the humerus (upper arm bone) of the patient to replace the articulating surface of the humerus.
Humeral component (shoulder/ proximal)	Part of a total or partial shoulder replacement that is inserted into the humerus (upper arm bone) of the patient. It normally consists of a humeral stem and head (ball) in conventional shoulder replacement or a humeral stem and a humeral cup in a reverse shoulder replacement.
Humeral head	Domed head portion of the humeral component of the artificial shoulder replacement attached to the humeral stem.
Humeral prosthesis	Portion of a shoulder replacement used to replace damaged parts of the humerus (upper arm bone).
Humeral stem	The part of a modular humeral component inserted into the humerus (upper arm bone). Has a humeral head or humeral cup mounted on it to form the complete humeral implant.
Hybrid procedure	Joint replacement procedure in which cement is used to fix one prosthetic component while the other is cementless. For hip procedures, the term hybrid covers both reverse hybrid (uncemented stem, cemented socket) and hybrid (cemented stem, uncemented socket) unless separately defined.
I	
ID	A generic term for pseudo anonymised patient identification number, whether that be a pseudo anonymised NHS number, local hospital patient identifier or combination of personal characteristics.
Image/computer-guided surgery	Surgery performed by the surgeon, using real-time images and data computed from these to assist alignment and positioning of prosthetic components.
Inconsistent operative pattern	A sequence of operations where the primary operation is not the first operation in the sequence or where there are multiple primary operations.
Independent hospital	A hospital managed by a commercial company that predominantly treats privately-funded patients but does also treat NHS-funded patients.
Index joint	The primary joint replacement that is the subject of an NJR entry.
Indication (for surgery)	The cause or reason for surgery. The NJR system allows for more than one indication to be recorded.
Ipsilateral procedure	An operation performed on one side, e.g. left or right knee procedures.
IQR	The interquartile range shows a range of values from the 25th (first quartile) and 75th (third quartile) centiles of a variables distribution.
ISTC	Independent sector treatment centre. See Treatment centre.

K	
Kaplan-Meier	Used to estimate the cumulative probability of 'failure' at various times from the primary operation, also known as Net Failure. 'Failure' may be either a first revision or a death, depending on the context. The method properly takes into account 'censored' data. Censorings arise from incomplete follow-up; for revision, for example, a patient may have died or reached the end of the analysis period (end of 2021) without having been revised.
L	
Lateral resurfacing (elbow)	Partial resurfacing of the elbow with a humeral surface replacement component used with a lateral resurfacing head inserted with or without cement.
LHMoM	Large head metal-on-metal. Where a metal femoral head of 36mm diameter or greater is used in conjunction with a femoral stem, and is articulating with either a metal resurfacing cup or a metal liner in a modular acetabular cup. Resurfacing hip replacements are excluded from this group.
Linkable percentage	Linkable percentage is the percentage of all relevant procedures that have been entered into the NJR, which may be linked via NHS number to other procedures performed on the same patient.
Linkable procedures	Procedures entered into the NJR database that are linkable to a patient's previous or subsequent procedures by the patient's NHS number.
Linked total elbow	Where the humeral and ulnar parts of a total elbow replacement are structurally coupled.
LMWH	Low molecular weight Heparin. A blood-thinning drug used in the prevention and treatment of deep vein thrombosis (DVT).
Lysis	Refers to osteolysis and describes focal periprosthetic loss of bone that occurs as an inflammatory response to debris generated from the prosthesis materials.
M	
MDS	Minimum Data Set, the set of data fields collected by the NJR. Some of the data fields are mandatory (i.e. they must be filled in). Fields that relate to patients' personal details must only be completed where informed patient consent has been obtained.
MDSv1	Minimum Data Set version one, used to collect data from 1 April 2003. MDSv1 closed to new data entry on 1 April 2005.
MDSv2	Minimum Data Set version two, introduced on 1 April 2004. MDSv2 replaced MDSv1 as the official dataset on 1 June 2004.
MDSv3	Minimum Data Set version three, introduced on 1 November 2007 replacing MDSv2 as the new official dataset.
MDSv4	Minimum Data Set version four, introduced on 1 April 2010 replacing MDSv3 as the new official dataset. This dataset has the same hip and knee MDSv3 dataset but includes the data collection for total ankle replacement procedures.
MDSv5	Minimum Data Set version five, introduced on 1 April 2012 replacing MDSv4 as the new official dataset. This dataset has the same hip, knee and ankle MDSv4 dataset but includes the data collection for total elbow and total shoulder replacement procedures.
MDSv6	Minimum Data Set version six, introduced on 14 November 2014 replacing MDSv5 as the new official dataset. This dataset includes the data collection for hip, knee, ankle, elbow and shoulder replacement procedures.
MDSv7	Minimum Data Set version seven, introduced on 4 June 2018 replacing MDSv6 as the new official dataset. This dataset includes reclassification and amendments to data collection for hip, knee, ankle, elbow and shoulder replacement procedures.
MHRA	Medicines and Healthcare products Regulatory Agency. The UK regulatory body for medical devices.
Minimally-invasive surgery	Surgery performed using small incisions (usually less than 10cm). This may require the use of special instruments.

Mix and match	Mix and match describes when the components of the joint construct come from different brands and/or manufacturers.
Modified Polyethylene (MP)	Any component made of polyethylene which has been modified in some way in order to improve its performance characteristics. Some of these processes involve chemical changes, such as increasing the cross-linking of the polymer chains or the addition of vitamin E and/or other antioxidants. Others are physical processes such as heat pressing or irradiation in a vacuum or inert gas.
Modular	Component composed of more than one piece, e.g. a modular acetabular cup shell component with a modular cup liner, or femoral stem coupled with a femoral head.
Monobloc	Component composed of, or supplied as, one piece, the antonym of modular e.g. a monobloc knee tibial component.
Multicompartmental knee replacement	More than one compartmental knee replacement within the same operation e.g. a unicondylar knee replacement and patellofemoral knee replacement, a medial and a lateral unicondylar knee replacement or a medial and a lateral and patellofemoral unicondylar knee replacement.
N	
NHS	National Health Service (E – England, I – Improvement, X – Digital).
NHS No.	Pseudo anonymised National Health Service Number.
NICE	National Institute for Health and Care Excellence.
NICE benchmark	The NICE benchmark of performance is defined as a 5% prosthesis failure rate at 10 years.
NJR	The National Joint Registry (NJR), which covers England, Wales, Northern Ireland, the Isle of Man and Guernsey, has collected and analysed information from both the NHS and independent healthcare sectors on hip and knee replacements since 1 April 2003, ankle replacements since 1 April 2010, and elbow and shoulder replacements since April 2012.
NJR Stats Online	Online facility for viewing and downloading NJR statistics at https://surgeonprofile.njrcentre.org.uk/Home/StatsIndex.
Non-inferiority framework	In non-inferiority design we test whether a construct is not worse than the best performing or benchmark construct, within a pre-specified range (the non-inferiority margin). Constructs which perform below this range are considered to be worse than or inferior to the benchmark.
O	
ODEP	Orthopaedic Data Evaluation Panel of the NHS Supply Chain. www.odep.org.uk.
ODEP ratings	A letter and star rating awarded to implants based on their performance at specified time points. See www.odep.org.uk for more details.
OPCS-4	Office of Population, Censuses and Surveys: Classification of Interventions and Procedures, version 4 – a list of surgical procedures and codes.
Outlier	Data for a surgeon, unit or implant brand that falls outside of acceptable control limits. See also 'Funnel plot'. A Level One implant outlier is defined as having a PTIR of more than twice the group average. A Level Two implant outlier is defined as having a PTIR of 1.5 times the group average.
OSS	Oxford Shoulder Score. A 12-item patient-reported outcome measure specifically designed and developed for assessing outcomes of shoulder surgery e.g. for assessing the impact on patients' quality of life of degenerative conditions such as arthritis and rotator cuff problems.
P	
Patellar resurfacing	Replacement of the surface of the patella (knee cap) with a prosthesis.
Patellofemoral knee replacement	Procedure involving replacement of the trochlear and replacement resurfacing of the patella.
Patellofemoral prosthesis	Two-piece knee prosthesis that provides a prosthetic (knee) articulation surface between the patella and trochlear.
Patient consent	Patient personal details may only be submitted to the NJR where explicit informed patient consent has been given or where patient consent has not been recorded. If a patient declines to give consent, only the anonymous operation and implant data may be submitted.

Patient physical status	See ASA.
PDS	The NHS Personal Demographics Service is the national electronic database of NHS patient demographic details. The NJR uses the PDS Demographics Batch Service (DBS) to source missing NHS numbers and to determine when patients recorded on the NJR have died.
PEDW	Patient Episode Database for Wales. The Welsh equivalent to Hospital Episode Statistics (HES) in England.
Primary hip/knee/ankle/elbow/ shoulder replacement	The first time a joint replacement operation is performed on any individual joint in a patient.
Procedure	A single operation. See also Primary hip/knee/ankle/elbow/shoulder replacement and Revision hip/ knee/ankle/elbow/shoulder replacement.
PROM(s)	Patient Reported Outcome Measure(s). Questionnaires completed by patients, giving insight as to how they individually feel and function both before and after surgery.
Prosthesis	Orthopaedic implant used in joint replacement procedures, e.g. a total hip, a unicondylar knee, a total ankle, a reverse shoulder or a radial head replacement.
Prosthesis-time	The total of the length of time a prosthesis was 'at risk' of revision. In the calculation of PTIRs for revision, for example, each individual prosthesis construct time is measured from the date of the primary operation to the date of first revision or, if there has been no revision, the date of patient's death or the administrative censoring date.
Proximal humeral hemiarthroplasty	A shoulder replacement procedure which replaces only the humeral side of the shoulder joint.
PTIR	Prosthesis-Time Incidence Rate. The total number of events (e.g. first revisions) divided by the total of the lengths of times the prosthesis was at risk (see 'Prosthesis-time').
Pulmonary embolism	A pulmonary embolism is a blockage in the pulmonary artery, which is the blood vessel that carries blood from the heart to the lungs.
R	
Radial head component (elbow)	Part of a partial elbow joint that is inserted into the radius (outer lower arm bone) of the patient to replace the articulating surface of the radial head. May be monobloc or modular.
Region	NJR regions are based on the former NHS Strategic Health Authority areas. These organisations were responsible for managing local performance and implementing national policy at a regional level until 2013.
Resurfacing (hip)	Resurfacing of the femoral head with a surface replacement femoral prosthesis and insertion of a monobloc acetabular cup, with or without cement.
Resurfacing (knee)	See Patellar resurfacing.
Resurfacing (shoulder)	Resurfacing of the humeral head with a surface replacement humeral prosthesis inserted, with or without cement.
Reverse polarity total shoulder replacement	Replacement of the shoulder joint where a glenoid head is attached to the scapula and the humeral cup to the humerus.
Revision burden	The proportion of revision procedures carried out as a percentage of the total number of surgeries on that particular joint.
Revision hip/knee/ankle/elbow/ shoulder replacement	A revision is defined as any operation where one or more components are added to, removed from or modified in a joint replacement or if a Debridement And Implant Retention (DAIR) with or without modular exchange is performed. Capturing DAIR with or without modular exchange commenced with the introduction of MDSv7. Prior to this DAIR with modular exchange was included as a single-stage revision but DAIR without modular exchange was not captured. Within the annual report, each of these procedure types is included in the analyses as a revision episode. This is distinct from the analyses in the surgeon, unit, and implant performance work streams where DAIR without modular exchange is not currently included as a revision outcome.

S	
Shoulder humeral hemiarthroplasty	Replacement of the humeral head with a humeral stem and head or shoulder resurfacing component which articulates with the natural glenoid.
Single-stage revision	A complete revision procedure carried out in a single operation, i.e. components removed and replaced under one anaesthetic.
SOAL	Lower Layer Super Output Areas. Geographical areas for the collection and publication of small area statistics. These are designed to contain a minimum population of 1,000 and a mean population size of 1,500. Please also see Office for National Statistics at www.ons.gov.uk.
Stemless shoulder replacement	A shoulder replacement where the most distal element of humeral section does not project beyond the metaphyseal bone of the proximal humerus.
Stemmed shoulder replacement	A shoulder replacement where the most distal element of humeral section projects into the diaphysis of the proximal humerus.
Subtalar	The joints between the talus and the calcaneum, also known as the talocalcaneal joints.
Surgical approach	Method used by a surgeon to gain access to, and expose, the joint.
Survival (or failure) analysis	Statistical methods to look at time to a defined failure 'event' (for example either first revision or death); see Kaplan-Meier estimates and Cox 'proportional hazards' models. These methods can take into account cases with incomplete follow-up ('censored' observations).
T	
Talar component	Portion of an ankle prosthesis that is used to replace the articulating surface of the talus at the ankle joint.
TAR	Total ankle replacement (total ankle arthroplasty). Replacement of both tibial and talar surfaces, in most cases implanted without cement.
TED stockings	Thrombo embolic deterrent (TED) stockings. Elasticised stockings that can be worn by patients following surgery and which may help reduce the risk of deep vein thrombosis (DVT).
THR	Total hip replacement (total hip arthroplasty). Replacement of the femoral head with a stemmed femoral prosthesis and insertion of an acetabular cup, with or without cement.
Thromboprophylaxis	Drug or other post-operative regime prescribed to patients with the aim of preventing blood clot formation, usually deep vein thrombosis (DVT), in the post-operative period.
Tibial component (ankle)	Portion of an ankle prosthesis that is used to replace the articulating surface of the tibia (shin bone) at the ankle joint.
Tibial component (knee)	Portion of a knee prosthesis that is used to replace the articulating surface of the tibia (shin bone) at the knee joint. May be modular or monobloc (one piece).
TKR	Total knee replacement (total knee arthroplasty). Replacement of both tibial and femoral condyles (with or without resurfacing of the patella), with or without cement.
Total condylar knee	Type of knee prosthesis that replaces the complete contact area between the femur and the tibia of a patient's knee.
Total elbow replacement	Replacement of the elbow joint which consists of both humeral and ulna prostheses.
Treatment centre	Treatment centres are dedicated units that offer elective and short-stay surgery and diagnostic procedures in specialties such as ophthalmology, orthopaedic and other conditions. These include hip, knee, ankle, elbow, and shoulder replacements. Treatment centres may be privately-funded (independent sector treatment centre – ISTC). NHS Treatment Centres exist but their data are included in those of the English NHS trusts and Welsh Local Health Boards to which they are attached.
Trochanter	Bony protuberance of the femur, the greater trochanter is found on its upper outer aspect and is the site of attachment of the abductor muscles. The lesser trochanter is medial and inferior to this and is the site of attachment of the psoas tendon.
Trochanteric osteotomy	A procedure to temporarily remove and then reattach the greater trochanter, used to aid exposure of hip joint during some types of total hip replacement and now usually used only in complex procedures.
Two-stage revision	A revision procedure carried out as two operations, i.e. under two separate anaesthetics, most often used in the treatment of prosthetic joint infection.
Type (of prosthesis)	Type of prosthesis is the generic description of a prosthesis, e.g. modular cemented stem (hip), patellofemoral joint (knee), talar component (ankle), reverse shoulder (shoulder) and radial head replacement (elbow).

U	
Ulnar component (elbow)	Part of a total elbow joint that is inserted into the ulna (inner lower arm bone) of the patient to replace the articulating surface of the ulna. May be linked or unlinked.
Uncemented	Prostheses designed to be fixed into the bone by an initial press-fit and then bony ingrowth or ongrowth, without using cement.
Unconfirmed prostheses construct	A joint replacement which has been uploaded with either an insufficient number of elements to form a construct, or prostheses elements which are not concordant with the procedure indicated by the surgeon.
Unicompartmental knee replacement	Procedure where only one compartment of the knee joint is replaced, also known as partial knee replacement. The lateral (outside), medial (inside) and patellofemoral (under the knee cap) compartments are replaced individually.
Unicondylar arthroplasty	Replacement of one tibial condyle and one femoral condyle in the knee, with or without resurfacing of the patella.
Unicondylar knee replacement	See Unicondylar arthroplasty.
Unilateral operation	Operation performed on one side only, e.g. left hip.
Unlinked total elbow	Where the humeral and ulnar parts of a total elbow replacement are apposed but not structurally coupled.

Summary of key facts about joint replacement during the 2021 calendar year

Hips

recorded on the NJR since April 2003

2021

84,998 primary replacement procedures

60% ♀

average ages:

67.2 ♂ 69.6 ♀

Data:

Acute trauma

Osteoarthritis

average BMI **28.7** = **'Overweight'**

Knees

recorded on the NJR since April 2003

2021

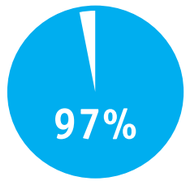
77,830 primary replacement procedures

54% ♀

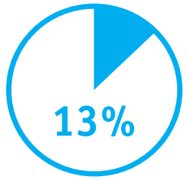
average ages:

68.8 ♂ 69.3 ♀

Data:



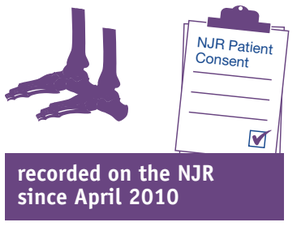
Osteoarthritis



Unicondylar knee replacements

average BMI **30.6** = **'Obese'**

Ankles



recorded on the NJR since April 2010

2021

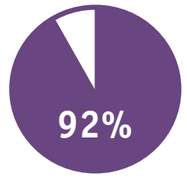
710 primary replacement procedures

39% ♀

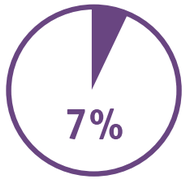
average ages:

69.0 ♂ 67.3 ♀

Data:



Osteoarthritis



Rheumatoid arthritis and other inflammatory joint problems

average BMI **29.5** = **'Overweight'**

Elbows

recorded on the NJR since April 2012

2021

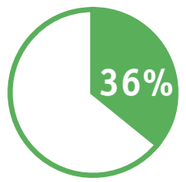
760 primary replacement procedures

69% ♀

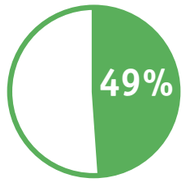
average ages:

53.3 ♂ 65.5 ♀

Data:



Total elbow replacement (with or without a radial head)



Radial head replacements

Distal humeral hemiarthroplasty

Shoulders

recorded on the NJR since April 2012

2021

5,529 primary replacement procedures

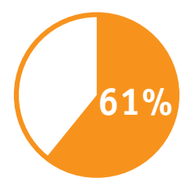
68% ♀

average ages:

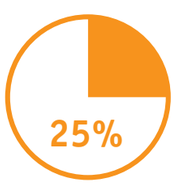
68.9 ♂ 73.2 ♀

Data:

Acute trauma



Osteoarthritis



Elective cuff tear arthropathy

For more data on clinical activity during the 2021 calendar year visit reports.njrcentre.org.uk

Information governance and patient confidentiality
The NJR ensures that all patient data is processed and handled in line with international and UK standards and within UK and European legislation: protecting and applying strict controls on the use of patient data is of the highest importance. NJR data is collected via a web-based data entry application and stored and processed in NEC Software Solutions (NEC) data centre. NEC is accredited to ISO/IEC 27001:2013, ISO/IEC 9001:2015, ISO/IEC 20000, Cyber Essentials Plus, and Healthcare Data Storage (HDS). NEC is also registered on the NHS Data Security and Protection Toolkit with a status of 'Exceeds Standards'.

For research and analysis purposes, NJR data is annually linked to data from other healthcare systems using patient identifiers, principally a patient's NHS number. These other datasets include the Hospital Episodes Statistics (HES) service, data from the NHS England Patient Reported Outcomes Measures (PROMs) programme, and Civil Registration data (all provided by NHS Digital), and the Patient Episode Database Wales (PEDW) (provided by Digital Health and Care Wales). The purpose of linking to these datasets is to expand and broaden the type of analyses that the NJR can undertake without having to collect additional data. This linkage has been approved by the Health Research Authority under Section 251 of the NHS Act 2006 on the basis of improving patient safety and patient outcomes: the support provides the legal basis for undertaking the linkage of NJR data to the health datasets listed above.

Once the datasets have been linked, patient identifiable data are removed from the new dataset so that it is not possible to identify any patient. This data is then made available to the NJR's statistics and analysis team at the University of Bristol whose processing of the data is compliant with the NHS Data Security and Protection Toolkit. The work undertaken by the University of Bristol is directed by the NJR's Steering Committee and the NJR's Editorial Commitee and the results of the analyses are published in the NJR's Annual Report and in professional journals. All published data is based on anonymised data, this means that no patient could be identified.

Terms and conditions for use of data
Do you wish to use NJR data and statistics for presentations, reports and other publications? In quoting or publishing NJR data, screen shots from NJR reports or websites we request that you reference the 'National Joint Registry'. State the time-period covered, procedures included and also include reference to any other filters that have been applied to the data. This is particularly important if the information is in the public domain.

Where possible, include a link to www.njrcentre.org.uk so that the audience is able to seek out further context and information on published joint replacement statistics.

Disclaimer
The NJR produces this report using data collected, collated and provided by third parties. As a result of this the NJR takes no responsibility for the accuracy, currency, reliability and correctness of any data used or referred to in this service, nor for the accuracy, currency, reliability and correctness of links or references to other information sources and disclaims all warranties in relation to such data, links and references to the maximum extent permitted by legislation.

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Produced by Pad Creative Ltd www.padcreative.co.uk

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At reports.njrcentre.org.uk, this document is available to download in PDF format along with additional data and information on NJR progress and developments, clinical activity as well as implant and unit-level activity and outcomes.

Every effort has been made at the time of publication to ensure that the information contained in this report is accurate. If amendments or corrections are required after publication, they will be published on the NJR website at www.njrcentre.org.uk and on the dedicated NJR Reports website at reports.njrcentre.org.uk.

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